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TRACTORS AND HORSES IN THE WINTER WHEAT BELT, OKLAHOMA, KANSAS, NEBRASKA.

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CONTENTS.

	Page.
Description of areas	4
Farms operated with one tractor and horses	5
Size and age of tractors	6
Number of work stock	7
Work done with tractors	8
Work done with horses	19
Horse labor equivalent of tractor work	22
Proportion of work done with different forms of power	23
Work stock needed in addition to tractor	26
Cost of keeping work stock	28
Cost of using tractors	32
Reliability of tractors	38
Annual cost of power for drawbar work	38
Farms operated with one tractor and horses—continued.	
Changes after purchase of tractor	43
Owners' opinions regarding use of tractors	49
Farms on which tractors were not owned	50
Number of work stock	50
Cost of keeping work stock	53
Annual cost of power for drawbar work	54
Changes between 1918 and 1921	55
Opinions concerning tractors	56
Cost of power and man labor for different operations	56
Farms on which no horses were owned	57
Farms on which two tractors were owned	58

During August and September, 1921, the United States Department of Agriculture, in cooperation with the Kansas State Agricultural College, and the College of Agriculture of the University of Nebraska, made a study of the use of power on 390 farms on which tractors were owned, in northern Oklahoma, Kansas, and Nebraska.[1] A personal visit was made to each farm and the following data obtained: (1) Work done during year with tractor; (2) work done during year with horses; (3) cost of using tractor; (4) cost of keeping work stock; (5) changes in operation and organization of farm after purchase of tractor; (6) opinions and ideas concerning use of tractor.

The investigation also included 85 farms on which tractors were not owned, but which were comparable in size to those on which tractors were being used. These were visited to obtain data which would afford a direct comparision between costs and practices on farms where tractors were owned and on farms of similar size and type where they were not owned.

[1] Acknowledgment is made to E. B. Krantz, Bureau of Animal Industry; H. A. Miller and J. W. Tapp Bureau of Agricultural Economics; J. H. Moyer and M. Evans, Kansas State College of Agriculture; and C. W. Smith and J. D. Parsons, College of Agriculture of the University of Nebraska, for assistance in collecting the data presented in this bulletin.

Three areas were selected for the investigation: (1) Harper County, Kansas, and Alfalfa County Okla., hereinafter referred to as the southern area; (2) Thomas, Sheridan, Trego, Gove and Logan Counties, Kans., hereinafter referred to as the western area; (3) Phelps and Kearney Counties, Nebr., hereinafter referred to as the northern area. The location of these areas is shown in Figure 1.

A report was obtained from any tractor owner willing and able to give the desired information provided he had owned his tractor for at least one year and was using it for drawbar work. A few of the men interviewed were using two tractors and a few did not own any horses.

The farms on which tractors were not owned were selected so that their average size would correspond as nearly as possible to the average size of the farms on which tractors were owned. In each area, however, tractors were in use on a majority of the larger farms and it would have been difficult if not impossible to find nontractor farms equal in number, size, and type to the farms on which tractors were owned.

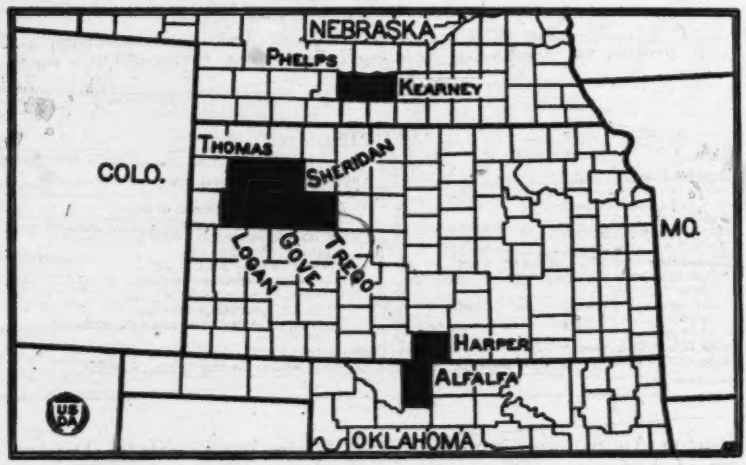

FIG. 1.—Areas in which investigation was made.

Table 1 shows the number of farms surveyed in each area classified according to the type of power used. The different classes of farms are discussed separately in the following pages.

TABLE I.—*Number of farms of different classes visited.*

Type of power.	Southern area.	Western Area.	Northern area.	Total.
1 tractor and horses	120	107	127	354
Horses only	26	31	28	85
1 tractor and no horses	4	11	0	15
2 tractors and horses	6	13	2	21
Total	156	162	157	475

The more important points brought out in the investigation concerning the 354 farms operated with one tractor and horses are summarized in Table 2, and concerning the 85 farms operated with horses only, in Table 3.

TABLE 2.—*Details of operation on farms on which one tractor and horses were owned.*

	Southern area.	Western area.	Northern area.	Total or average.
Number of farms	120	107	127	354
Size of farm.....acres	326	842	377	500
Crop area per farm.....do	262	516	299	352
Area in wheat (seeded 1920).....do	213	407	177	250
Tractor work per year:				
Drawbar (home farm).....hours	365	350	203	302
Belt (home farm).....do	24	19	33	26
Custom.....do	50	53	41	48
Total.....do	439	422	277	376
Fuel per year for drawbar work:				
Gasoline.....gals	531	345	111	324
Kerosene.....do	301	379	332	336
Oil per year for drawbar work.....do	57	54	34	48
First cost of tractor.....dollars	1,499	1,556	1,375	1,473
Estimated total life.....years	6.8	6.3	7.4	6.8
Annual cost of repairs and upkeep.....dollars	106	46	57	71
Cost of using tractors for drawbar work:				
Per year.....dollars	588	520	357	484
Per hour.....do	1.61	1.49	1.76	1.60
Work stock per farm.....number	7.5	10.2	7.4	8.3
Horse labor:				
Per farm per year.....hours	3,690	3,816	4,206	3,914
Per head per year.....do	472	393	566	482
Cost per hour of horse labor.....cents	22	18	13	17
Annual feed consumption, per head:				
Grain.....pounds	1,529	1,247	2,421	1,765
Hay and roughage.....do	2,600	2,440	3,200	2,820
Pasture.....months	6.6	7.4	4.5	6.1
Cost of keeping work stock:				
Per farm.....dollars	583	522	517	541
Per head.....do	76	50	69	64
Cost per year of power for drawbar work:				
Total (tractor and work stock).....dollars	1,171	1,042	874	1,025
Per crop acre.....do	4.47	2.02	2.92	3.17
Horse labor equivalent of total drawbar work:				
Per farm.....hours	6,812	7,483	5,930	6,670
Per crop acre.....do	26	15	19	19
Proportion of total drawbar work done with tractors.per cent	45	46	28	40
Increase in size of farm after purchase of tractor.....crop acres	18	98	44	50
Work stock per farm if tractors were not used.....number	10.1	15.2	9.6	11.7
Necessary work stock per farm in addition to tractor.....do	5.7	7.4	6.5	6.5
Crop acres per horse:				
Before purchase of tractors	26	34	31	30
1921	35	51	40	42
Potential crop acres per horse	46	70	46	54
Reduction per head in feed for work stock after purchase of tractors:				
Grain.....per cent	20	27	17	21
Hay and roughage.....do	[1] 2	15	6	7
Reduction in family and regular hired labor.....months	1.2	2.5	0.8	1.4
Net increase in combined cost of power and labor due to using tractors.....dollars	343	157	172	208
Proportion of owners who charged tillage practice.....per cent	69	62	65	66
Proportion who believed tractors responsible for increased yield per acre.....per cent	29	14	20	21
Proportion who believed present tractors would be profitable.....per cent	78	84	65	75
Proportion who intend to buy others.....do	75	85	59	72

[1] Increase.

TABLE 3.—*Details of operation on farms on which tractors were not owned.*

	Southern area.	Western area.	Northern area.	Total farms.
Number of farms	26	31	28	85
Size of farm.....acres	316	779	376	504
Crop area per farm.....do	250	446	288	334
Area in wheat (seeded 1920).....do	196	323	164	222
Work stock per farm.....number	9.8	12.2	9.3	10.5
Value per head.....dollars	108	71	111	94
Necessary work stock per farm.....number	9.8	11.7	8.7	10.1
Cost of keeping work stock:				
Per farm.....dollars	838	670	608	701
Per head.....do	84	54	65	66
Annual feed consumption, per head:				
Grain.....pounds	2,073	1,780	2,927	2,248
Hay and roughage.....do	3,160	3,140	3,060	3,140
Pasture.....months	6.1	6.4	3.9	5.5
Horse labor:				
Per farm per year.....hours	6,819	6,658	5,561	6,346
Per head per year.....do	709	565	610	634
Cost per hour of horse labor.....cents	13	10	12	11
Increase in size of farm 1918 to 1921.....crop acres	9	78	43	45
Crop acres per horse:				
1918.....do	25	33	28	30
1921.....do	26	37	31	32
Crop acres per necessary horse.....do	26	38	33	33

DESCRIPTION OF AREAS.

Southern area.—According to the 1920 census of agriculture the avearge size of all farms in the southern area was 242 acres, 191 acres of which were classed as improved. On the average 119 acres of wheat, 62 per cent of the improved area, were harvested in 1919.

Nearly all of the land is level and suitable for cultivation. Rainfall is usually sufficient to produce a crop of wheat. On the farms visited the yield per acre of the wheat harvested in 1921 was 20 bushels. Wheat is practically the only cash crop. Little livestock is kept, and on many of the farms none is raised for sale.

Tillage practices in this area are more intensive than in either of the other areas visited. Nearly all the land planted to wheat is either plowed or listed and sledded, and in addition much of it is gone over with a disk harrow. Most of the harvesting is done with the binder and the wheat is usually threshed from the shock.

Western area.—According to the 1920 census of agriculture the average size of all farms in the five counties in the western area visited was 737 acres, 527 of which were classed as improved. In 1919 159 acres of wheat per farm were harvested.

The topography of much of the land makes it unsuitable for cultivation. This rough land has never been broken and most of it is utilized for grazing purposes. On most of the farms visited a larger part of the land was under cultivation, and the proportion of the area in wheat (see Table 4) was much larger than the average for the area. The rainfall is often insufficient to make a crop of wheat. The average yield in 1921 on the farms visited was 8 bushels per acre, and on many it was 5 bushels or less.

Tillage practices are less intensive than in either of the other areas. Less than half of the land in wheat on the farms visited had been plowed previous to seeding, part of the remainder had been disked and on part the wheat had been sowed in the previous year's stubble without any preparation whatever. Headers are commonly used for

harvesting. However, in both this and the southern area a considerable number of tractor owners use combined harvesters and threshers.

Northern area.—According to the 1920 census of agriculture the average size of all farms in the two counties of the northern area visited was 245 acres, 215 acres of which were classed as improved. An average of 86 acres of wheat and 58 acres of corn per farm were harvested in 1919. Corn occupies a greater acreage in this area than in either of the others. It is usually planted with a combined lister and drill without previous preparation of the ground. Wheat is usually planted on the corn land, much of it with one-horse drills which go between the rows of standing corn. Where the corn is cut the land is usually disked before the wheat is planted. Where wheat follows wheat the land is usually plowed before planting. The average yield per acre of wheat harvested in 1921 on the farms visited was 14 bushels.

FARMS OPERATED WITH ONE TRACTOR AND HORSES.

Table 4 shows the average size of the 354 farms operated with one tractor and horses and the acreage devoted to different crops in the different areas.

TABLE 4.—*Average size of farms and crop acreage in different areas.*

Area.	Number of farms.	Crop acreage.											Area not cropped.	Total area of farm.
		Wheat.	Barley.	Oats.	Other small grain.	Corn.	Other row crops.	Alfalfa.	Other hay.	Sowed feed.[1]	Other crops.	Total.		
		Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Southern....	120	213	2	13	.....	13	4	9	1	4	3	262	64	326
Western....	107	407	22	8	2	25	9	1	8	18	.5	516	326	842
Northern ..	127	177	8	10	.....	81	.....	6	13	4	.....	299	78	377
Total.....	354	259	13	10	1	41	4	5	8	8	3	352	148	500

[1] Cane, Sudan grass, etc.

The average size of these farms is considerably larger than the average size of all farms in the different areas, and the proportion of the area in wheat was somewhat greater than for all farms as shown by census figures. On nearly every farm visited in the southern and western areas, and on most of the farms in the northern area, wheat occupied a greater acreage than any other crop and determined the amount of power kept on the farm. On the average the proportion of the crop area of the farms surveyed in wheat (seeded 1920) was 81 per cent in the Southern area, 79 per cent in the Western area, 59 per cent in the Northern area, and for all farms 74 per cent.

The number of farms of different sizes based on crop acreage operated with one tractor and horses in the different areas is shown in Table 5.

The size of the farms in the western area was considerably greater than in the other areas, but tillage practices and yields were such that on the average practically the same amount of power was used per farm in each of the three areas.

TABLE 5.—*Number of farms of different sizes in different areas operated with one tractor and horses.*

Size of farm (crop acres).	Southern area.	Western area.	Northern area.	Size of farm (crop acres).	Southern area.	Western area.	Northern area.
Less than 160	20	.....	10	480–639	5	22	8
160–239	36	5	27	640–799	.....	14	.....
240–319	34	17	46	800 and over	.....	12	.....
320–399	18	18	29				
400–479	7	19	7	Total	120	107	127

SIZE AND AGE OF TRACTORS.

The number of tractors of different sizes in use in the different areas and the average size in crop acres of the farms on which they were used, are shown in Table 6. The tractors are classified according to the number of 14-inch moldboard plows pulled. The three-plow size predominated in each area. In general the larger tractors were found on the larger farms.

TABLE 6.—*Number of tractors of different sizes in use in different areas and size of farms on which they are used.*

Size of tractor.	Southern area.		Western area.		Northern area.		All farms.	
	Number.	Crop acres.	Number.	Crop acres.	Number.	Crop acres.	Number.	Crop acres.
		Per farm.		*Per farm.*		*Per farm.*		*Per farm.*
2-plow	28	202	34	436	26	239	88	303
3-plow	73	273	49	516	85	297	207	340
4-plow	16	312	14	577	10	444	40	437
Over 4-plow	3	273	10	705	6	343	19	522
Total	120	262	107	518	127	299	354	352

The number of tractors which at the time of the investigation had been in use for different lengths of time is shown in Table 7. A considerably larger percentage of the tractors in the Western area than in the other areas had been in use just one year. This was in the main due to the fact that the wheat crop of 1920 was good. The crops of 1918 and 1919 had been poor and few farmers had purchased tractors in those years.

TABLE 7.—*Age of tractors.*

Area.	Number of farmers who had used tractors:				Average age of tractors.
	14 months or less.	15 to 26 months.	27 to 38 months.	39 months or over.	
					Months.
Southern	38	43	25	12	24
Western	81	16	3	7	18
Northern	25	53	39	11	27
Total	144	113	67	30	23

NUMBER OF WORK STOCK.

The total number, weight, and value of work stock of different kinds owned at the time of the investigation on the farms operated with one tractor and horses are given in Table 8. The values of the work stock shown are the averages of the farmers' estimates of their value at the time of the investigation (August and September, 1921).

TABLE 8.—*Total number of work stock, their weight, and value in different areas.*

Area.	Number of farms.	Mares.			Geldings.			Mules.			All work stock.	
		Number.	Average weight.	Average value.	Number.	Average weight.	Average value.	Number.	Average weight.	Average value.	Average number per farm.	Average value per head.
			Pounds.			*Pounds.*			*Pounds.*			
Southern	120	420	1,298	$102	258	1,259	$86	226	1,100	$113	7.5	$100
Western	107	581	1,269	96	405	1,230	83	108	1,086	101	10.2	92
Northern	127	448	1,113	110	384	1,305	107	105	1,118	118	7.4	110
Total	354	1,449	1,229	102	1,047	1,265	93	439	1,101	111	8.3	100

The number of colts in comparison with the number of work stock on these farms is shown in Table 9. The number of "other" colts includes all young stock over 1 year of age which have not been broken to harness. Colts less than 1 year of age were found on only about one-third of the farms, and there was no young stock whatever on nearly half of the farms. For all farms there was 1 colt less than a year old for each 10.4 head of work stock and 1 "other" colt for each 4.5 head. This is considerably more than enough for replacement for the entire group of farms.

In the southern area the ratio of the number of colts less than 1 year of age to the total number of work stock was 1: 10.6; in the western area 1: 7.3; and in the northern area 1: 19.9.

TABLE 9.—*Number of work stock and number of colts in different areas.*

Area.	Total number of farms.	Total number of work stock.	Colts less than 1 year of age.		Other colts.		Number of farms—		
			Horse.	Mule.	Horse.	Mule.	With colts less than 1 year of age.	With other colts.	With no colts.
Southern	120	904	23	52	135	128	39	62	44
Western	107	1,094	108	42	225	48	55	55	37
Northern	127	937	31	16	59	55	21	40	75
All	354	2,935	172	110	419	231	115	157	156

The number of work stock kept depended to a certain extent upon the size of the farm. The average numbers on the farms of different sizes are shown in Table 10. There was considerable variation, however, in the number kept on farms of the same size in the same area. Many of the tractor owners were keeping more work stock

than they considered necessary for the proper operation of their farms. The necessary number depends to a certain extent upon the operations for which the tractors are used. (See p. 11.)

TABLE 10.—*Number of work stock on farms of different sizes.*

Size of farm (crop acres).	Southern area.		Western area.		Northern area.	
	Number of farms.	Average number of work stock.	Number of farms.	Average number of work stock.	Number of farms.	Average number of work stock.
Less than 160	20	4.8	.....	.....	10	4.1
160–239	36	6.9	5	6.4	27	5.5
240–319	34	7.7	17	7.8	46	7.0
320–399	18	9.9	18	7.6	29	8.8
400–479	7	10.3	19	7.1	7	10.4
480–639	5	9.4	22	12.5	8	12.1
640–799	.....	.....	14	12.3	.....	.....
800 and over	.....	.....	12	17.8	.....	.....
Total	120	7.5	107	10.2	127	7.4

WORK DONE WITH TRACTORS.

On the average tractors were used for 376 hours during the year. Drawbar work on the home farm consumed 302 hours, or 80 per cent of the total; belt work on the home farm, 26 hours, or 7 per cent of the total; and custom work the remainder. The number of hours of drawbar work performed was least in the northern area, and likewise the proportion of the total drawbar work done with tractors was considerably less than in the other areas. (See Table 25.)

TABLE 11.—*Hours of tractor work per year on farms of different sizes.*

Area.	Size of farm in crop acres.								
	Less than 160	160 to 239	240 to 319	320 to 399	400 to 479	480 to 639	640 to 799	800 and over.	All farms.
Southern.									
Farms, number	20	36	34	18	7	5	.....	.....	120
Hours of tractor work:									
Drawbar (home farm)	279	307	331	452	429	608	.....	.....	365
Belt (home farm)	2	13	30	42	39	51	.....	.....	24
Custom	34	63	48	42	73	56	.....	.....	50
Total	315	383	459	536	541	715	.....	.....	439
Western.									
Farms, number	.....	5	17	18	19	22	14	12	107
Hours of tractor work:									
Drawbar (home farm)	.....	213	221	228	385	419	464	458	350
Belt (home farm)	.....	6	7	19	24	22	21	24	19
Custom	.....	129	64	60	41	47	54	30	53
Total	.....	348	292	307	450	488	539	512	422
Northern.									
Farms, number	10	27	46	29	7	8	.....	.....	127
Hours of tractor work:									
Drawbar (home farm)	157	142	207	238	223	297	.....	.....	203
Belt (home farm)	14	15	25	56	44	73	.....	.....	33
Custom	21	41	34	42	75	83	.....	.....	41
Total	192	198	266	336	342	453	.....	.....	277

Table 11 and Figure 2 show the number of hours tractors were used for different kinds of work on farms of different sizes in the three areas.

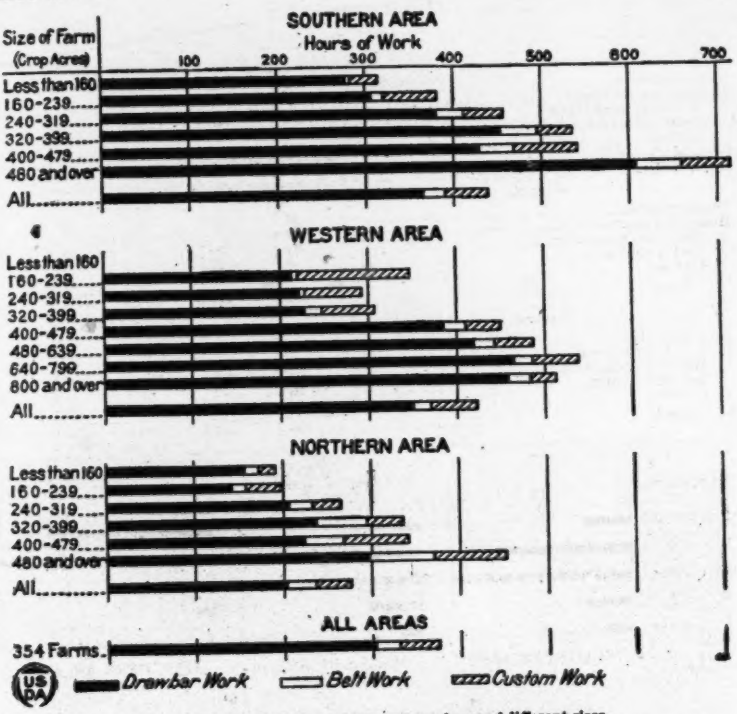

FIG. 2.—Hours of tractor work per year on farms of different sizes.

There was a larger percentage of small machines on the smaller farms than on the larger ones and to this extent the number of hours of work per year is not a true index of the amount of work done by the tractors on the farms of different sizes. The table shows, however, the relative importance of the different classes of work.

The work done annually by an individual tractor depends upon the particular field operations for which it is used, the amount of belt and custom work done, and to a certain extent upon the amount of time it is out of running order when needed, as well as upon the size of the farm. The variation in the number of hours work done during the year by the 354 tractors is shown in Figure 3.

The number of hours the different sizes of tractors were used for different classes of work is shown in Table 12. The two-plow machines did considerably less belt and custom work in each area than did the larger sizes. For all areas, 88 per cent of the work done by the two-plow machines was drawbar work on the home farm, and only 26 machines, 29 per cent of the total number, did any belt work whatever. Most of the belt work on these farms is threshing, and the small tractors are not powerful enough to drive most of the threshing machines used. (See p. 15.)

TABLE 12.—*Work done annually by tractors of different sizes.*

Area.	Size of tractor.				
	2-plow.	3-plow.	4-plow.	Over 4-plow.	All farms.
Southern.					
Farms, number	28	73	16	3	120
Hours of tractor work:					
Drawbar (home farm)	360	368	384	160	365
Belt (home farm)	3	28	44	14	24
Custom	34	51	68	86	50
Total	397	447	496	260	439
Western.					
Farms, number	34	49	14	10	107
Hours of tractor work:					
Drawbar (home farm)	344	350	350	368	350
Belt (home farm)	7	17	48	24	19
Custom	41	67	31	65	53
Total	392	434	429	457	422
Northern.					
Farms, number	26	85	10	6	127
Hours of tractor work:					
Drawbar (home farm)	209	203	223	127	205
Belt (home farm)	20	33	61	41	33
Custom	21	40	101	52	41
Total	250	276	395	220	277

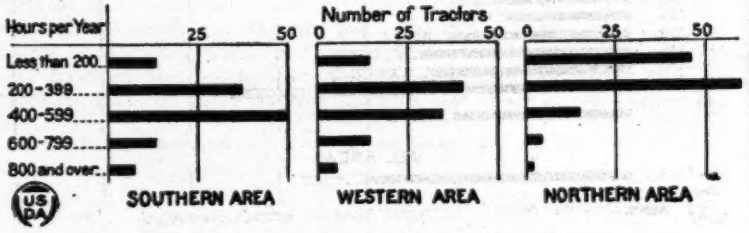

FIG. 3.—Variation in number of hours per year tractors were used.

DRAWBAR WORK.

The average number of hours the tractors were used for various kinds of drawbar work is shown in Table 13. In each area they were used more for plowing and listing than for any other kind of work. On part of the farms tractors were used for practically every field operation except haying and cultivating row crops. They were used for drawing corn binders on 3 farms in the southern area, on 7 farms in the western area, and on 2 farms in the northern area.

TABLE 13.—*Hours per year tractors were used for drawbar operations.*

Operation.	Southern area.	Western area.	Northern area.	All farms.
	Hours.	*Hours.*	*Hours.*	*Hours.*
Plowing and listing	140	141	122	134
Disking, harrowing, and sledding	127	69	16	70
Listing row crops	(1)	6	7	4
Drilling grain	42	76	23	45
Harvesting grain	54	56	34	48
Miscellaneous	2	2	1	1
Total	365	350	203	302

[1] Less than 0.5 hour.

Plowing and listing.—Table 14 shows the number of acres plowed and listed per farm and the percentage done with tractors. On the average 18 acres per farm were plowed in the spring and 140 acres in the fall. The spring plowing was usually for spring grain or "sowed feed" (cane, Sudan grass, etc.), and only a small amount of either of these crops was raised on the average farm. (See Table 14). Listing was not common in any except the southern area.

Fall plowing required more power than any other single operation in each area, and the tractors did a larger proportion of this than any other operation. On many of the farms the tractors did all of the fall plowing and on only a very few farms were horses used for as much as 50 per cent of it. (See fig. 4.)

FIG. 4.—The 3-plow tractor is the most common size used. Tractors are used more for plowing and listing than for any other operation.

TABLE 14.—*Plowing and listing per farm and percentage done with tractors.*

Operation.	Southern Area.	Western area.	Northern area.	Average all farms.
Spring plowing:				
Acres per farm with tractors	4	23	7	10
Acres per farm with horses	9	7	9	8
Total	13	30	16	18
Percentage done with tractors	31	77	44	56
Fall plowing:				
Acres per farm with tractors	111	132	117	119
Acres per farm with horses	18	21	23	21
Total	129	153	140	140
Percentage done with tractors	86	86	84	85
Listing:				
Acres per farm with tractors	44	5	0	16
Acres per farm with horses	31	2	0	11
Total	75	7	0	27
Percentage done with Tractors	59	71	.....	59

TABLE 15.—*Disking, sledding, and harrowing per farm and percentage done with tractors.*

Operation.	Southern area.	Western area.	Northern area.	Average all farms.
Disking unplowed ground:				
Single disk—				
Acres per farm with tractor	(1)	2	3	2
Acres per farm with horses	3	13	47	22
Total	3	15	50	24
Percentage done with tractor		13	6	8
Tandem disk—				
Acres per farm with tractor	22	145	12	56
Acres per farm with horses	6	14	0	6
Total	28	159	12	62
Percentage done with tractor	79	91	100	90
Disking plowed ground:				
Single disk—				
Acres per farm with tractor	15	0	1	5
Acres per farm with horses	8	2	5	5
Total	23	2	6	10
Percentage done with tractor	65			50
Tandem disk—				
Acres per farm with tractor	82	3	3	30
Acres per farm with horses	4	0	(1)	1
Total	86	3	3	31
Percentage done with tractor	95			97
Sledding:				
Acres per farm with tractor	18	3	0	7
Acres per farm with horses	46	1	0	16
Total	64	4	0	23
Percentage done with tractor	28			30
Harrowing:				
Acres per farm with tractor	149	3	32	63
Acres per farm with horses	70	24	123	75
Total	219	27	155	138
Percentage done with tractor	68	11	21	46

[1] Less than 0.5 of an acre.

Fitting ground other than plowing.—Table 15 shows the number of acres disked, harrowed, and sledded per farm during the year and the percentage of each operation done with tractors. The acreages for disking and harrowing have been computed on the basis of once over the ground. That is, if a farmer disked or harrowed an 80-acre field twice it has been considered as 160 acres.

Sledding is an operation performed only after listing and consequently was not common except in the southern area. It is a comparatively light operation and on farms where listing and sledding were carried on simultaneously tractors were ordinarily used for listing and horses for sledding.

Disking is separated into work done on plowed and unplowed ground and into that done with single and double disks. Disking plowed ground was not practiced to any extent except in the southern area and most of it there was done with a tandem disk and tractor. Disking unplowed ground was carried on most extensively in the western area and there also most of the work was done with the tandem disk and tractor. In the northern area the single disk was used more extensively than the tandem disk, and it was usually drawn by horses.

Harrows are used but little in the western area. In the southern area tractors were used on 68 per cent of the acreage harrowed during the year, and in the northern area on only 21 per cent.

In addition to the work shown in the table, tractors were used for disking in combination, that is drawing disks and drills or disks and harrows simultaneously on 42 acres per farm in the southern area, 16 acres in the western area, and 1 acre in the northern area.

Drilling grain and planting row crops.—The acres of grain drilled and of row crops planted per farm and the proportion of the acreages covered with tractors are shown in Table 16. The acreages covered with drills in combination with disks are not included. In the northern area a considerable part of the wheat was drilled between the rows of standing corn with one-horse drills (see p. 5), and this accounts, at least in part, for the greater use of horses for drilling in that area. Drawing a combined lister and drill when planting corn and other row crops is a rather heavy operation, four horses ordinarily being used on a one-row implement, but on the average only 17 per cent of this work was done with tractors.

TABLE 16.—*Drilling and planting per farm and percentage done with tractors.*

Operation.	Southern area.	Western area.	Northern area.	All farms.
Drilling:				
Acres per farm with tractor	106	231	58	126
Acres per farm with horses	111	186	138	143
Total	217	417	196	269
Percentage done with tractor	49	55	30	47
Planting row crops:				
Acres per farm with tractor	(1)	10	13	8
Acres per farm with horses	17	25	69	38
Total	17	35	82	46
Percentage done with tractor		29	16	17

[1] Less than 0.5 acre.

Harvesting.—The acreage of wheat and other small grain harvested with binders, headers, and combines, and the percentage done with tractors are shown in Table 17. In the southern and northern areas the greater part of the crop was harvested with binders, but in the western area over 85 per cent was harvested either with the header or combine. In each area tractors were used on a little more than half of the acreage cut with binders; they were always used for drawing the combine, but horses were ordinarily used for the headers. (See figs. 5 and 6.)

On nearly every farm where the tractor was used for drawing any one of these three machines a man was used on the machine as well as on the tractor; that is, one man more than would have been used if horses had furnished the power. In most cases where headers and combines were used horses drew the header barges and the grain wagons for the combines. In some cases, however, combination hitches were used and the entire outfit was drawn by the tractor.

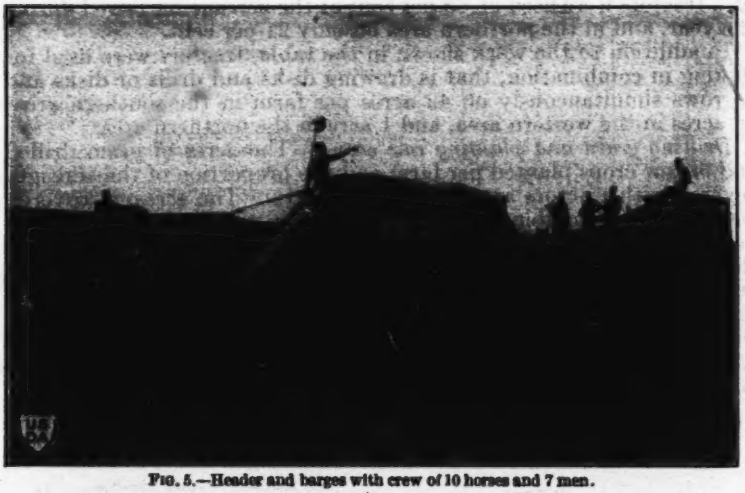

FIG. 5.—Header and barges with crew of 10 horses and 7 men.

FIG. 6.—A combined harvester and thresher. A tractor of at least the three-plow size is required to draw this machine.

TABLE 17.—*Harvesting with binders, headers, and combines and percentage done with tractors.*

Operation.	Southern area.	Western area.	Northern area.	All farms.
Harvesting with binders:				
Acres per farm with tractor	106	27	89	76
Acres per farm with horses	79	19	60	57
Total	185	46	158	133
Percentage done with tractor	57	59	56	57
Harvesting with headers:				
Acres per farm with tractor	1	66	4	21
Acres per farm with horses	11	226	32	84
Total	12	292	36	105
Percentage done with tractor	8	23	11	20
Harvesting with combines:				
Acres per farm with tractor	18	72	2	29

BELT WORK.

The use of the tractor for belt work does not compete with horse labor and should really be considered a separate enterprise, but the doing of such work may be the means of making the tractor a profitable investment. As shown in Table 11 the entire 354 tractors were used for an average of 26 hours of belt work on the home farm during the year. However, 182 tractors, a little over half of the total, were not used for this class of work at all. For the remaining 172, belt work amounted to an average of 53 hours for the year.

Table 18 shows the number of tractors used for different belt operations on the home farm during the year and the average amount of time devoted to each operation. In the southern and western areas about 40 per cent of the tractors and in the northern area about two-thirds of them were used for some belt work. A larger number of the tractors were used for threshing than for any other belt operation, but only 84, a little less than a fourth of the total number were used for this work.

TABLE 18.—*Number of tractors used for belt work and hours of use per year.*

Operation.	Southern area.		Western area.		Northern area.		All farms.	
	Number used.	Hours of use per year.	Number used.	Hours of use per year.	Number used.	Hours of use per year.	Number used.	Hours of use per year.
Threshing	28	81	23	48	33	51	84	60
Grinding feed	13	17	14	38	30	18	57	23
Shelling corn	4	7	4	10	32	28	40	24
Cutting silage	4	19	8	20	11	33	23	25
Shredding fodder	0	.....	1	25	10	35	11	34
Other	17	15	5	30	15	27	37	22
Total and average, all belt work	46	62	43	47	83	51	172	53

It is shown in Table 12 that on the average the two-plow tractors did not do so much belt work as the three-plow and larger sizes. Table 19 shows the number of tractors of different sizes which were used for belt work in the different areas and the number of hours of

work per year which they did. In all, 30 per cent of the two-plow machines and 55 per cent of the three-plow and larger ones were used for belt work. On many of the farms, especially in the southern and western areas, threshing was the only belt work done during the year and the two-plow tractors have scarcely enough power to operate the prevailing sizes of separators. (See fig. 7.)

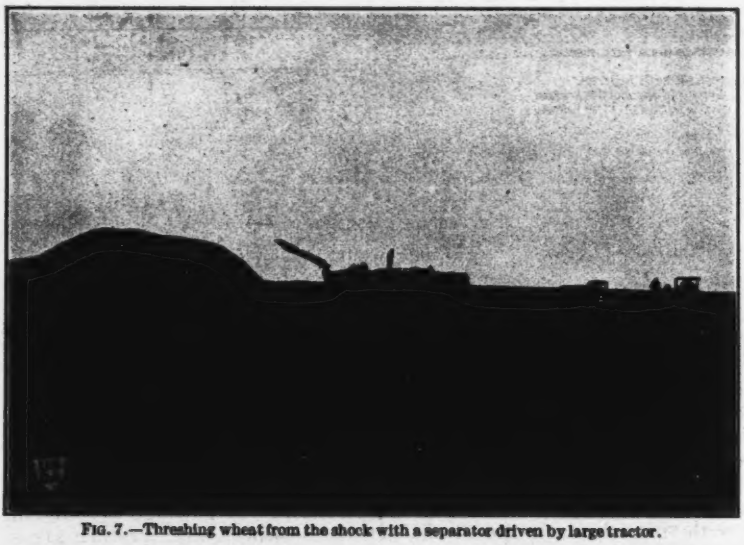

FIG. 7.—Threshing wheat from the shock with a separator driven by large tractor.

TABLE 19.—*Number of tractors of different sizes used for belt work and hours of use per year.*

Size of tractor.	Southern area.		Western area.		Northern area.		All farms.	
	Number used.	Hours of use per year.	Number used.	Hours of use per year.	Number used.	Hours of use per year.	Number used.	Hours of use per year.
2-plow	7	12	7	38	12	44	26	33
3-plow	29	69	24	38	58	49	111	51
4-plow	8	87	7	95	7	87	22	90
Over 4-plow	2	28	5	48	6	41	13	42
Total and average, all sizes	46	62	43	47	83	51	172	53

A complete record of all the belt work done on each farm during the year both with the tractor and other engines was obtained and Table 20 shows for the average farm in each area the total amount of power used for the different belt operations and the proportion furnished by the tractors. Only one tractor owner used his horses to furnish power for stationary work.

The number of horsepower hours was obtained in every case by multiplying the horsepower of the engine by the number of hours

used. Often the total power which the engine was capable of developing was not required for the work, but the method of conducting the investigation was such that it was not possible to obtain a more accurate measure of the power actually utilized for the different classes of belt work.

For all farms the tractors did 33 per cent of the belt work. Threshing constituted 82 per cent of the total belt work done and the tractors

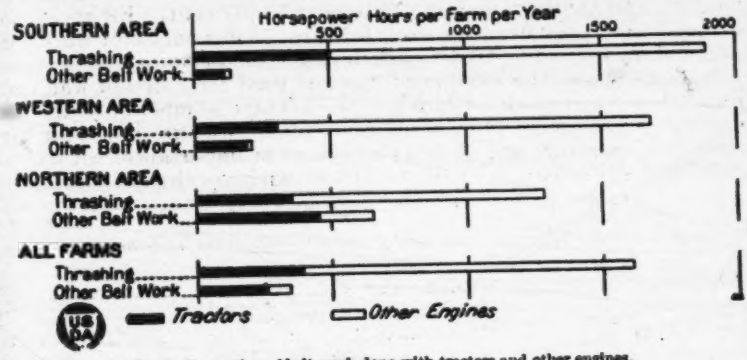

FIG. 8. Proportion of belt work done with tractors and other engines.

furnished the power for 24 per cent of it. On the farms where combines were used the power furnished by the engines on the threshers has been included under "other engines" and the power furnished by the tractors for drawing the combine is included under drawbar work. Figure 8 shows graphically the relative importance of threshing and other belt work in each area and the percentage done with the farm tractors.

TABLE 20.—*Percentage of belt work done with tractors and other engines.*

[Horsepower hours per farm.]

Area.	Threshing.	Grinding feed.	Shelling corn.	Cutting silage.	Shredding fodder.	Other belt work.	Total.
Southern area:							
Tractors	504	44	4	18	0	49	619
Other engines	1,383	1	3	0	0	15	1,402
Total	1,887	45	7	18	0	64	2,021
Percentage done with tractors	27	98	.....	100	.....	77	31
Western area:							
Tractors	303	113	8	38	4	35	501
Other engines	1,379	(1)	2	12	0	0	1,393
Total	1,682	113	10	50	4	35	1,894
Percentage done with tractors	18	100	80	76	.....	100	26
Northern area:							
Tractors	358	96	155	65	64	74	812
Other engines	926	35	155	0	5	1	1,122
Total	1,284	131	310	65	69	75	1,934
Percentage done with tractors	28	73	50	100	93	99	42
All farms:							
Tractors	391	84	60	41	24	54	654
Other engines	1,218	13	57	4	2	5	1,299
Total	1,609	97	117	45	26	59	1,953
Percentage done with tractors	24	87	51	91	92	93	33

[1] Less than 0.5 horsepower hour.

CUSTOM WORK.

One hundred seventy-five of the 354 tractors were used for some custom work during the year. As shown in Table 11 such work amounted to an average of 48 hours for all tractors, or 98 hours for the 175. About 23 per cent of the work done by these 175 tractors was custom work. For 111 of the 175, custom work amounted to 25 per cent or less of the total work done. For 50 it amounted to 26 to 50 per cent, and for the remaining 14 to over 50 per cent. Eighty-three of the 175 did only drawbar work for hire, 72 did only belt work for hire, and the remaining 20 did both drawbar and belt work.

Table 21 shows the number of tractors used for different kinds of drawbar and belt work for hire and the average number of hours per year they were used. More tractors were used for threshing than for any other operation and plowing was next in importance. A somewhat smaller percentage of the two-plow machines than of the three-plow and larger sizes were used for custom work.

TABLE 21.—*Number of tractors used for different kinds of custom work and hours of use per year.*

Operation.	Southern area.		Western area.		Northern area.		All farms.	
	Number used.	Hours of use per year.	Number used.	Hours of use per year.	Number used.	Hours of use per year.	Number used.	Hours of use per year.
Drawbar:								
Plowing	14	63	17	57	12	59	43	59
Disking	10	37	16	85	0	.....	26	66
Drilling	5	50	10	73	4	28	19	57
Drawing combine	4	72	6	74	0	.....	10	73
Drawing binder	5	35	2	15	1	28	8	29
Road work	3	53	5	39	6	45	14	46
Other	16	43	6	60	3	41	25	44
Belt:								
Threshing	25	101	12	114	27	90	64	98
Shelling corn	2	118	1	30	12	110	15	106
Cutting silage	2	17	1	10	8	19	11	18
Shredding fodder	0	.....	0	.....	5	25	5	25
Other	10	54	4	59	2	32	16	53
Total	64	96	50	114	61	86	175	98

TRACTORS USED FOR NEITHER BELT NOR CUSTOM WORK.

While on the average only 80 per cent of the total work done by tractors was drawbar work on the home farm, 115, or 33 per cent, of the 354 tractors were used for nothing but this class of work during the year. The number which were used for different classes of work was as follows: 115 for drawbar work on home farm only; 64 for drawbar and belt work on home farm only; 67 for drawbar work on home farm and custom work; 108 for drawbar, belt, and custom work.

Forty-six, or 52 per cent, of the two-plow machines did nothing but drawbar work on the home farm during the year, while all but 71, or 27 per cent, of the three-plow and larger sizes were used for either belt or custom work. In each area the percentage of the two-plow machines whose use was confined to drawbar work on the home farm was considerably greater than of the three-plow and larger sizes.

WORK DONE WITH HORSES.

Table 22 shows the number of hours of horse labor used per farm for different kinds of work.

TABLE 22.—*Average number of hours of horse labor per farm.*

Operation.	Average number of hours per farm.			
	Southern area.	Western area.	Northern area.	All farms.
	Hours.	*Hours.*	*Hours.*	*Hours.*
Spring plowing	93	82	72	82
Fall plowing	179	189	199	189
Listing	140	8	0	50
Total plowing and listing	412	279	271	321
Disking plowed ground	41	6	14	21
Disking unplowed ground	39	112	133	95
Harrowing	121	40	175	116
Sledding	180	4	0	62
Other fitting ground	0	2	2	1
Total fitting ground other than plowing and listing	381	164	324	295
Drilling	284	454	361	363
Drawing grain binder	218	50	169	149
Stacking grain	10	16	77	36
Drawing header	41	488	65	185
Drawing header wagons	28	362	48	136
Total harvesting grain crops	297	916	359	506
Threshing	690	209	342	420
Planting row crops	87	128	313	181
Cultivating row crops	122	171	564	295
Drawing row binder	13	59	122	66
Hauling silage corn	13	20	14	16
Husking corn	90	161	286	182
Total harvesting row crops	116	240	422	264
Mowing hay	60	39	51	50
Raking hay	33	20	27	27
Loading and hauling hay	63	52	26	46
Sweeping and stacking hay	22	31	48	34
Total haying operations	178	142	152	157
Hauling feed	204	350	301	253
Hauling manure	114	89	200	141
Miscellaneous work on farm	319	230	178	241
Total miscellaneous work	637	669	688	665
Hauling grain on road	439	360	305	368
Other road hauling	47	84	105	79
Total road hauling	486	444	410	447
Total horse labor per farm	3,690	3,816	4,206	3,914
Horse labor hired out	236	40	11	96
Grand total horse labor per farm	3,926	3,856	4,217	4,010
Horse labor hired for threshing	331	10	7	118
Other horse labor hired	23	79	12	36
Total horse labor hired	354	89	19	154
Total labor by horses owned	3,572	3,767	4,198	3,856

FIELD WORK.

Tables 14 to 17 show the number of acres farmed with horses in the operations for which both tractors and horses are used, and the number of hours of horse labor shown in Table 22 for these operations

is the number of hours required to cover those acreages. Horses were used almost entirely for cultivating, haying, stacking grain, drawing header wagon, hauling bundled grain to the thrasher and thrashed grain to the bin, and for harvesting row crops. For all farms this field work directly connected with growing and harvesting the crops constituted about 72 per cent of the total work done with horses.

OTHER WORK.

A considerable part of the hay grown on these farms was stacked in the field and hauled to the barn or feed lot when needed. Corn and other row crops when cut for fodder or stover were usually left in the field and hauled in when needed. These operations and the hauling of other feed to livestock required an average of 283 hours of horse labor per farm.

An average of 141 hours of horse labor was used for hauling manure. On many of the farms, however, no manure was hauled during the year. The placing of manure on the fields, especially in the western area, is of doubtful value.

Miscellaneous work such as mowing weeds, repairing fences, hauling water to livestock, etc., required an average of 241 hours of horse labor per farm.

In all, the work not directly connected with growing and harvesting crops made up about 17 per cent of the total done with horses.

On the average 82 per cent of the road hauling done with horses consisted of hauling grain to market. Wheat was the only cash crop on most of the farms, and in the southern and western areas nearly all of the other road hauling consisted of hauling supplies to the farm. In the northern area a considerable number of farmers raised hogs for sale, which they hauled to market with their horses.

HORSE LABOR HIRED.

In the southern area much of the threshing was done by custom threshermen who furnished the entire crew, which accounts for the larger amount of horse labor hired for threshing in that area. Many of the farmers hired men and teams to these custom threshermen for the season, and this in turn accounts for the large amount of horse labor hired out in that area.

WORK DONE WITH TWO-HORSE TEAMS.

All farmers in the areas visited, regardless of whether they owned tractors or not, used large teams and implements for field work whenever practicable; but about half the work done with horses on the farms where tractors were owned was done with two-horse teams.

Practically all of the plowing, fitting ground, drilling, drawing grain binders, headers, and row binders was done with teams of three to six horses. Three or four horses were nearly always used for planting and cultivating row crops. But two-horse teams were used entirely for haying, stacking grain, drawing header wagons, hauling unthreshed grain to the separator and threshed grain to the bin, harvesting row crops and making silage, except drawing the binder, and hauling feed and manure. Nearly all of the miscellaneous work on the farm and road hauling was also done with two-

horse teams. On the average farm these operations which were all or nearly all done with two-horse teams required 2,059 hours of horse labor, or 53 per cent of the total. In the southern area they required 58 per cent of the total, in the western area 53 per cent, and in the northern area 48 per cent. Much of this work is of such nature that it can not be done advantageously with larger power units. (See fig. 9.)

FIG. 9.—Two-horse teams were used entirely for haying on these farms. Implements requiring the power of more than two horses can not be used advantageously for this and many other kinds of work on wheat farms.

Table 23 shows the number of hours of labor performed during the year by the horses on farms of different sizes and the average number of hours of work per head. For all farms the horses worked 482 hours per head during the year. The amount of horse labor used on a particular farm depended, of course, not only on its size but also on the crops raised, the amount of work done on them and the proportion done with the tractor. In general, a greater amount of horse labor was used on the larger farms, and the number of hours of work per head was also greater on the larger farms. There were wide variations, however, even on farms of similar size and type. Figure 10 shows graphically the variations in the hours of horse labor per head in each area.

All of the work connected with harvesting, threshing and seeding wheat on these farms must be done during July, August, and September, and since wheat occupies so large a proportion of the acreage the amount of work done per year by each horse will necessarily be lower than on more diversified farms with better distribution of labor. However, on many of the farms visited more work stock was

being kept than was needed in addition to the tractor to carry on the work properly and this accounts in part for the low utilization of the work stock.

TABLE 23.—*Labor by horses owned on farms of different sizes.*

Size of farm (crop acres).	Southern area.			Western area.			Northern area.		
	Number of farms.	Horse labor.		Number of farms.	Horse labor.		Number of farms.	Horse labor.	
		Per farm.	Per head.		Per farm.	Per head.		Per farm.	Per head.
		Hours.	*Hours.*		*Hours.*	*Hours.*		*Hours.*	*Hours.*
Less than 160	20	1,328	315				10	1,977	468
160 to 239	36	2,680	405	5	1,544	373	27	3,081	560
240 to 319	34	4,141	548	17	2,992	373	46	3,808	560
320 to 399	18	4,952	508	18	3,061	440	29	5,058	582
400 to 479	7	5,945	612	19	2,957	449	7	5,877	575
480 to 639	5	6,822	749	22	4,103	346	8	8,401	680
640 to 799				14	5,402	465			
800 and over				12	5,753	313			
Total and average	120	3,572	472	107	3,767	393	127	4,198	566

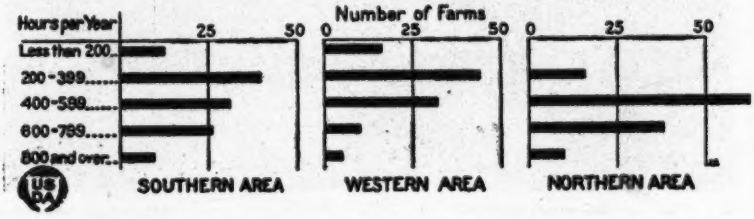

FIG. 10.—Variation in number of hours per head work stock was used

HORSE LABOR EQUIVALENT OF TRACTOR WORK.

Table 24 shows the horse labor equivalent of the drawbar work done by the average tractor in each area; that is, the number of hours of horse labor which would have been required to do the same work. For example, the average tractor in the southern area did 110.5 acres of fall plowing during the year. For the fall plowing done with horses in this area an average of 10.1 hours of horse labor per acre was required, and thus the work of fall plowing done by the average tractor was the equivalent of 1,116 hours of horse labor in this area.

Comparison of the horse labor equivalent of the total drawbar work done by the tractors in the different areas with the number of hours required by the tractors to do this work (see Table 11) shows that while actually in use the average tractor did the equivalent of the work of 8.3 head of work stock in the southern area, 9.9 head in the western area, 8.2 head in the northern area, and 8.7 head for all farms.

The work stock on these farms were used on the average for 482 hours per head during the year (see p. 21). Thus the average tractor did as much work during the year as was done by 5.5 horses (2,638

divided by 482). In the southern area the average tractor did as much work as 6.4 head of work stock; in the western area 8.8, and in the northern area 2.9.

TABLE 24.—*Horse labor equivalent of tractor work.*

Operation.	Horse hours per farm.			
	Southern area.	Western area.	Northern area.	All farms.
Spring plowing	36	256	55	102
Fall plowing	1,116	1,212	1,011	1,098
Listing	196	24	.....	73
Total plowing and listing	1,348	1,492	1,066	1,273
Disking plowed ground	339	11	14	124
Disking unplowed ground	108	688	66	268
Disking in combination	232	90	8	108
Harrowing	254	6	45	94
Sledding	72	8	.....	28
Total fitting ground other than plowing and listing	1,005	803	133	622
Drilling	276	554	150	316
Drawing binder	297	71	222	198
Drawing header	3	144	8	47
Drawing combine	83	324	11	130
Total harvesting	383	539	241	375
Planting row crops	2	53	59	38
Miscellaneous	17	19	7	14
Total	3,031	3,460	1,656	2,638

The work stock on the farms where tractors were owned did not do as much work per head as on the 85 similar farms in the same areas where tractors were not owned. (See Table 60.) An average of 624 hours of horse labor per head was performed on the farms where tractors were not owned, compared with 482 hours on the farms where tractors were owned. The average tractor did as much work as was done by 4.2 head of work stock (2,638 divided by 624) on the nontractor farms. In the southern area the average tractor did as much work as was done by 4.3 head on the nontractor farms; in the western area, 6.1 head; and in the northern area, 2.7 head.

PROPORTION OF WORK DONE WITH DIFFERENT FORMS OF POWER.

Table 25 shows the average number of hours of horse labor per farm used on the different operations, the horse labor equivalent of the drawbar work done by the tractors, the total number of hours of horse labor which would have been required if the tractors had not been used and the percentage of the total done with tractors. The same items are shown graphically in Figure 11.

Measured by the number of hours of horse labor required, the tractors did 40 per cent of all the drawbar work on these farms. In the southern area they did 45 per cent; in the western area, 46 per cent; and in the northern area, 28 per cent.

The greater part of the work done with the tractors required the steady pulling of heavy loads, while a considerable part of that done with horses was hauling and other work which did not require the

steady pulling of heavy loads. Consequently if it had been possible to measure the work done by the tractors and horses in terms of drawbar pull and distance traveled the proportion done by the tractors would have been considerably greater.

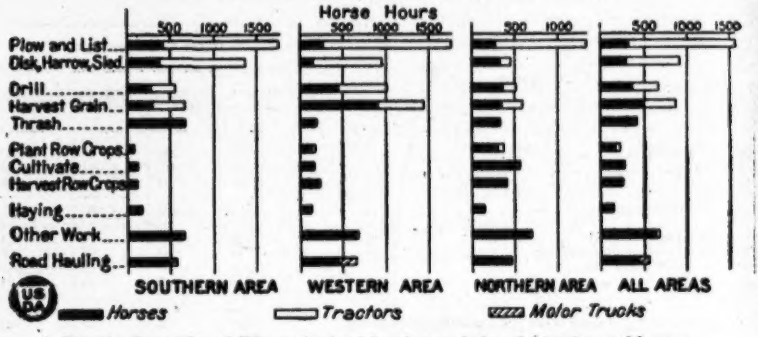

FIG. 11.—Proportion of different kinds of drawbar work done by tractors and horses.

TABLE 25.—*Proportion of different operations done with horses and tractors.*

Operation.	Southern area.				Western area.			
	Hours of horse-labor per farm.	Horse-labor equivalent of tractor work.	Total.	Percentage with tractor.	Hours of horse-labor per farm.	Horse-labor equivalent of tractor work.	Total.	Percentage with tractor.
Plowing and listing	412	1,348	1,760	77	279	1,492	1,771	84
Disking, harrowing, and sledding	381	1,005	1,386	72	164	803	967	83
Drilling	284	276	560	49	454	554	1,008	55
Harvesting grain	297	383	680	56	916	539	1,455	37
Threshing (drawbar)	690	0	690	0	209	0	209	0
Planting row crops	87	2	89	2	128	53	181	29
Cultivating row crops	122	0	122	0	171	0	171	0
Harvesting row crops	116	0	116	0	240	0	240	0
Haying	178	0	178	0	142	0	142	0
Miscellaneous	637	17	654	3	669	19	688	3
Road hauling	486	[1] 91	577	[1] 16	444	[1] 207	651	[1] 31
Total	3,690	[2] 3,081	6,812	44	3,816	[2] 3,460	7,483	46

Operation.	Northern area.				All farms.			
	Hours of horse-labor per farm.	Horse-labor equivalent of tractor work.	Total.	Percentage with tractor.	Hours of horse-labor per farm.	Horse-labor equivalent of tractor work.	Total.	Percentage with tractor.
Plowing and listing	271	1,066	1,337	80	321	1,273	1,594	80
Disking, harrowing, and sledding	324	133	457	29	295	622	917	68
Drilling	361	150	511	29	363	316	679	46
Harvesting grain	359	241	600	40	506	375	881	42
Threshing (drawbar)	342	0	342	0	420	0	420	0
Planting row crops	313	59	372	16	181	38	219	17
Cultivating row crops	564	0	564	0	295	0	295	0
Harvesting row crops	422	0	422	0	264	0	264	0
Haying	152	0	152	0	157	0	157	0
Miscellaneous	668	7	695	1	665	14	679	2
Road hauling	410	[1] 68	478	[1] 14	447	[1] 118	565	[1] 21
Total	4,206	[2] 1,656	5,930	28	3,914	[2] 2,638	6,670	40

[1] Motor trucks.

[2] Motor truck hauling not included.

Motor trucks were used for part of the road hauling on these farms, 82 of the 354 farmers having made some use of trucks, either hired or owned, during the year. The horse-labor equivalent of the motor truck hauling and the percentage of the total road hauling done with them are also shown in Table 25.

For the average farm the equivalent of 6,670 hours of horse labor—19 hours per crop acre—was used for drawbar work during the year. The intensity of tillage, however, was different in the three areas. In the southern area the equivalent of 26 hours of horse labor per crop acre was used; in the western area, 15 hours; and in the northern area, 19 hours. These figures are practically the same in every case as the averages of the actual number of hours of horse labor per crop acre on the farms where tractors were not owned. (See Table 61.)

Table 26 and Figure 12 show the total amount of power used per farm for both drawbar and belt work (with the exception of that done with engines of 4-horse power or less), and the proportion furnished by horses, farm tractors, and other engines and motor

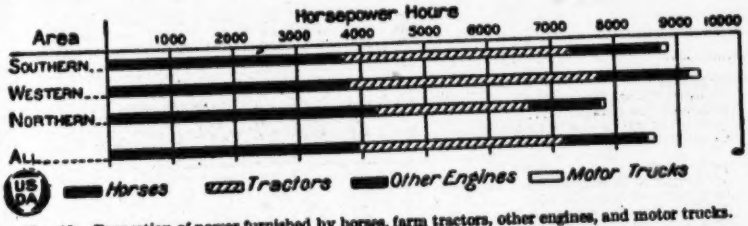

FIG. 12.—Proportion of power furnished by horses, farm tractors, other engines, and motor trucks.

trucks. The figures for the total amount of power used and the proportions furnished by the different sources of power are based on the assumption that 1 horse hour of drawbar work is the equivalent of 1 horsepower hour of belt work. While there are wide variations in the proportion of the available power actually utilized both on drawbar work and on belt work, these figures give the best available approximation of the total amount of power used for all work on these farms.

TABLE 26.—*Total power per farm for drawbar and belt work in different areas.*

[Based on the assumption that 1 horse hour of drawbar work is equivalent to 1 horsepower hour of belt work.]

Area.	Horse-hour equivalent of power for drawbar work.	Horse-power hours for belt work.	Total.	Per cent power for belt work is of total.	Per cent of total power (drawbar and belt) furnished by tractor.	Per cent of total power furnished by horses.	Per cent of total power furnished by other engines.	Per cent of total power furnished by motor trucks.
Southern	6,812	2,021	8,833	23	41	42	16	1
Western	7,483	1,894	9,377	20	42	41	15	2
Northern	5,930	1,934	7,864	25	31	54	14	1
Total and average	6,670	1,953	8,623	23	38	46	15	1

WORK STOCK NEEDED IN ADDITION TO TRACTOR.

Each tractor owner visited was asked for a statement of the number of work stock which he considered necessary in addition to the tractor for the proper operation of his farm, and it was found that a great many of them were keeping surplus horses. Table 27 shows the average number of work stock kept and the number of crop acres per horse at the time of the investigation on the farms of different sizes, together with the average number of work stock needed and crop acres per necessary horse. For the entire 354 farms an average of 8.3 head of work stock per farm—one for each 42 crop acres—was being kept at the time of the investigation. Operators considered that they needed only 6.5 head, one for each 54 crop acres.

TABLE 27.—*Work stock owned and work stock needed in addition to tractor.*

Area.	Size of farm (crop acres).								
	Less than 160.	160 to 239.	240 to 319.	320 to 399.	400 to 479.	480 to 639.	640 to 799.	800 and over.	All farms.
Southern area:									
Number of work stock owned	4.8	6.9	7.7	9.9	10.3	9.4	.....	.....	7.5
Crop acres per horse	27	29	36	36	40	57	.....	.....	35
Number of work stock needed	3.5	4.7	6.1	7.6	8.8	8.4	.....	.....	5.7
Crop acres per necessary horse	37	43	46	47	47	64	.....	.....	46
Western area:									
Number of work stock owned	.....	6.4	7.8	7.6	7.1	12.5	12.3	17.8	10.2
Crop acres per horse	.....	34	36	46	62	45	57	59	51
Number of work stock needed	.....	4.5	5.5	5.9	5.1	8.5	8.8	13.4	7.4
Crop acres per necessary horse	.....	49	51	59	85	65	80	79	70
Northern area:									
Number of work stock	4.1	5.5	7.0	8.8	10.4	12.1	.....	.....	7.4
Crop acres per horse	33	37	39	42	42	48	.....	.....	40
Number of work stock needed	4.1	4.7	5.9	8.1	8.7	12.0	.....	.....	6.5
Crop acres per necessary horse	33	43	47	46	50	49	.....	.....	46

The number of work stock which a man considered necessary depended not only on the size of his farm but upon the size and type of his tractor and the particular operations for which he considered his tractor satisfactory. Consequently there was considerable variation in the statements as to the number of work stock needed in addition to the tractors on farms of similar sizes. In general the men with smaller farms considered that they needed a proportionally greater number of work stock than did the men with larger farms. The men on the smaller farms, however, were not keeping a greater number of surplus work stock than were the men on larger farms. Of the 56 men in the Southern area with less than 240 acres in crops, 26 considered that they needed 4 horses in addition to their tractors and 12 considered that they needed 2, but only 15 of the 56 were keeping 4 head or less. Likewise, of the 52 men in this area with 240 to 399 acres in crops, 32 considered that they needed 6 head or less, but only 15 were keeping 6 head or less. Of the 22 men in the western area with less than 320 acres in crops, 11 considered that they needed 4 head and 2 considered that 2 horses were sufficient for their needs. However, all but 3 of the 22 were keeping more than 4 head. Of the 37 with 320 to 479 crop acres, 27 considered that they needed 6 head or less, but only 18 were keeping 6 head or less. Of the 37 men

in the northern area with less than 240 acres in crops, 24 considered that they needed 4 head and one considered that he needed only 2, but only 13 of the 37 were keeping 4 head or less. Of 46 men with 240 to 319 crop acres 36 considered that they needed 6 head or less, but only 18 were keeping 6 head or less.

Table 28 shows the exact number of surplus work stock on the different farms. In all, 158 tractor owners, about 45 per cent, considered that they needed all the work stock they were keeping. One hundred and eighty-one, about 50 per cent, were keeping more than they considered necessary, and the remaining 15 were keeping less than they considered necessary. A little over 20 per cent were keeping at least four head of surplus horses.

TABLE 28.—*Number of surplus work stock on different farms.*

	Southern area.	Western area.	Northern area.	All farms.
Number of tractor owners who were keeping—				
4 head less work stock than needed	1			1
3 head less work stock than needed			1	1
2 head less work stock than needed	2	1	1	4
1 head less work stock than needed	2	3	4	9
Same number as needed	40	43	68	158
Number of tractor owners who were keeping—				
1 head more work stock than needed	14	10	22	46
2 head more work stock than needed	16	4	19	39
3 head more work stock than needed	10	6	5	21
4 head more work stock than needed	10	13	7	30
5 head more work stock than needed	4	5		9
6 head more work stock than needed	3	6	1	10
7 head more work stock than needed	5	3	1	9
8 head more work stock than needed		3		3
9 head more work stock than needed	2	3		5
10 head more work stock than needed	2	2		4
More than 10 more work stock than needed		5		5

The surplus work stock on these farms was largely responsible for the low number of hours of work per head. (See Table 23.) No record was obtained as to the number of hours which the surplus work stock were used during the year or whether some of these men used horses on work which they would have done with tractors if the surplus work stock had not been available, but on a large proportion of the farms the work done by the horses and tractors would not have been changed if the surplus work stock had not been available. If the surplus work stock had been sold and no change made in the amount of work done with horses there would have been an average of about 625 hours of horse labor per head in the southern area; 510 hours in the western area, 645 hours in the northern area, and 595 hours for all farms. This is 84 hours per head less in the southern area 55 hours less in the western area, and 35 hours more in the northern area than was done by work stock on the farms on which tractors were not owned. (See Table 61.)

The low prices of horses had kept many farmers from disposing of their surplus work stock and although in general the cost per head of keeping work stock on the farms where they did a small number of hours of work per year was somewhat lower than on farms where the work stock were utilized more fully (see Table 35), in most cases the total annual cost of power for operating the farm would have been reduced if the surplus work stock had been sold.

COST OF KEEPING WORK STOCK.

A record of the amount and value of feed consumed by the work stock, the amount of time spent in taking care of them, the value and depreciation of work harness, change in the value of the work stock, and the cash outlay for shoeing and veterinary service was obtained from each farmer. These items, together with interest at 8 per cent on the value of the work stock, were included in determining the cost of keeping them. Deductions were made for manure produced and colts foaled during the year. Table 29 shows the average cost per head in the different areas during the year covered by the investigation.

TABLE 29.—*Annual cost per head of keeping work stock, 1921.*

Area.	Number of farms.	Cost per head.									Net cost per head.
		Feed.	Chores.	Harness.	Shoeing.	Veterinary.	Interest.	Depreciation.	Manure credit.	Colt credit.	
Southern	120	$49.14	$6.06	$4.77	$0.05	$0.73	$8.28	$11.33	$3.00	$1.64	$75.72
Western	107	29.84	5.44	4.63	.02	.24	7.56	7.20	1.50	2.98	50.45
Northern	127	41.91	11.07	4.17	.05	.83	8.97	7.93	5.00	.96	68.97
All	354	39.75	7.42	4.53	.04	.58	8.23	8.71	3.09	1.92	64.25

There were great variations in the cost per head of keeping the work stock on different farms. On 100 of the 354 farms the cost per head was less than $50 and on 67 farms it was over $90. This cost was influenced to a certain extent by the amount of work which the horses did. (See Table 35.) On some farms injuries or untimely deaths had been responsible for heavy depreciation and resultant high cost, but on a great many farms the cost per head of keeping

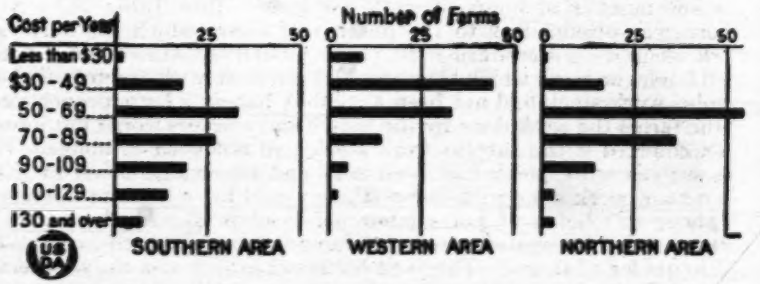

FIG. 13.—Variation in cost per head of keeping work stock.

the work stock could have been reduced considerably by better management. Figure 13 shows graphically the variation in the cost per head in the different areas.

Feed.—Table 30 shows the average annual consumption per head of the different kinds of feed in each area. For all farms the work stock consumed an average of 2,820 pounds of hay, straw, and stover and 1,766 pounds of grain per head during the year.

Only straw which was hauled and fed in the barn or feed lot is included in the quantities shown in Table 30 and in the value of feed in Table 29. On practically every farm the work stock had access to the straw piles when on pasture. Since the straw had no sale value, no attempt was made to obtain a record of the amount of straw consumed from piles.

On practically every farm in the southern and western areas and on many of the farms in the northern area the work stock were on wheat pasture during most of the winter. The length of time during the working season when the work stock was on night pasture only was also obtained from the farmers.

The consumption of hay and grain per head on these farms is considerably lower than in some other sections of the country. On 253 Corn-Belt farms on which tractors were owned the work stock consumed an average of 6,120 pounds of hay, straw, and stover and 2,830 pounds of grain during the year.[3] The low consumption was due in part to the long pasture season and to the comparatively small amount of work done by the horses. On most of the farms the amount of feed consumed per head had been reduced after the purchase of tractors. (*See* Table 50.)

The consumption of hay and roughage per head on these farms was about 10 per cent lower and of grain about 20 per cent lower than on the farms in the same areas where tractors were not owned. (See Table 63.) The average value, as given by their owners, of the grain, hay, and pasture consumed by work stock during the year is shown in Table 31.

TABLE 30.—*Feed for work stock.*

Area.	Average annual consumption per head.										
	Hay.	Straw and stover.	Oats.	Barley.	Corn.	Pasture.				Total hay and roughage.	Total grain.
						Grass.	Wheat.	Stalk.	Night.		
	Tons.	*Tons.*	*Bush.*	*Bush.*	*Bush.*	*Month.*	*Month.*	*Month.*	*Month.*	*Lbs.*	*Lbs.*
Southern	1.20	0.10	33.2	1.2	6.7	2.6	4.0	.....	2.7	2,600	[1] 1,529
Western	1.21	0.01	12.9	12.6	4.1	3.6	3.8	.....	2.7	2,440	1,247
Northern	1.38	0.22	18.9	2.6	30.2	1.9	1.0	1.6	3.1	3,200	2,421
All	1.27	0.14	21.9	5.1	14.4	2.6	2.9	0.6	2.8	2,820	[1] 1,765

[1] In addition to grain shown an average of 0.5 bushel of kafir and 6 pounds of other concentrates per head was fed in the southern area, an average of 0.2 of a bushel of kafir and 2 pounds of concentrates for all farms.

TABLE 31.—*Value of horse feeds in different areas, 1921.*

Area.	Corn per bushel.	Oats per bushel.	Barley per bushel.	Hay per ton.	Pasture.		
					Grass per month.	Wheat per month.	Stalk per month.
Southern	$0.72	$0.56	$0.60	$12.00	$1.23	$1.84	.....
Western	.55	.41	.42	7.00	1.07	1.44	.....
Northern	.50	.39	.44	9.00	1.26	1.34	$0.67

[3] See U. S. Department of Agriculture Bulletin No. 997, "The Cost and Utilization of Power on Farms where Tractors are Owned," by H. R. Tolley and L. A. Reynoldson. 1921.

Chores.—An estimate of the number of hours spent during the year in caring for the work stock was obtained from each farmer and the value of this time at 20 cents per hour was included in the cost. The average amount of time required for chores was about 37 hours per horse or 307 hours per farm for the year, about one hour of chores for each 13 hours of horse labor.

Harness.—The value of all the work harness owned and an estimate of the remaining number of years of service it would give was obtained from each farmer. The harness costs as shown in Table 29 are made up of interest and depreciation, interest being charged at 8 per cent of the value at the time the investigation was made and depreciation determined by dividing the value by the remaining years of life.

Depreciation of work stock.—Each farmer was asked for the value of his work stock at the time of the investigation, the extent to which they had depreciated on account of age, injury, or disease, and the extent to which any had appreciated in value during the year. There had been a considerable decline in the price of horses and mules during the year covered by the investigation, but this is not included in the depreciation figure given in Table 29.

Losses by death during the year had occurred as follows: In the southern area, 39 head out of a total of 904; in the western area, 31 head out of a total of 1,094; in the northern area, 26 out of a total of 937. The value of the work stock which had died during the year is included in the depreciation figure.

Manure Credit.—A manure credit of $3 per head in the southern area, $1.50 in the western area, and $5 in the northern area was allowed. These values are very nearly in proportion to the amounts of manure utilized in the different areas. (See Table 22 for the amount of horse labor used in hauling manure).

Colt Credit.—There was a very poor sale for young colts during the year covered by the investigation, and most farmers who had young colts were unable to place a fair value on them. Consequently in computing costs the value of horse colts foaled during the year was credited to the value of work stock at a flat rate of $25 per head minus breeding fee, and of mule colts, $35. As shown in Table 9 there were colts less than 1 year of age on only 115 of the 354 farms. Colt credit amounted to $1.92 per head of work stock for all farms and about $6 per head for the 115 farms.

COST OF KEEPING WORK STOCK IN 1922 AND 1923.

The computed cost of keeping the work stock on the farms visited in each area for the years ended August 1, 1922, and August 1, 1923, is shown in Tables 32 and 33.

The reports of the Division of Crop and Livestock Estimates show that for the year ended August 1, 1922, the farm value of corn in Kansas was 60 per cent, and the value for the year ended August 1, 1923, was 91 per cent of the value for the year covered by the survey; for oats, the value during 1922 was 71 per cent, and during 1923, 98 per cent of the value during the survey year; for barley, the value during 1922 was 71 per cent and 1923, 90 per cent of the value during the survey year; for hay, the value during 1922 was 71 per cent and 1923, 83 per cent of the value during the year covered by the survey.

No values for the different kinds of pasture are available for the years of 1922 and 1923, but the value of pasture follows closely changes in the value of hay.

The costs of feed, as shown in Tables 32 and 33, were obtained by using the amounts shown in Table 30, and the values for corn, oats, barley, and hay, as shown in Table 31, reduced the percentages given above. The value of pasture was reduced in the same proportion as hay.

The reports of the Division of Crop and Livestock Estimates also show that the farm value of horses in Kansas for the year ended August 1, 1922, was 75 per cent, and for the year ended August 1, 1923, 67 per cent of the value during the year covered by the survey. The interest and depreciation charges as shown in Table 29 were reduced by these percentages to obtain the corresponding figures in Tables 32 and 33. No change has been made in the charges for chores, harness, shoeing, and veterinary, and none in the credits for manure and colts.

TABLE 32.—*1922 cost per head of keeping work stock.*

Area.	Feed.	Chores.	Harness.	Shoeing.	Veterinary.	Interest.	Depreciation.	Manure credit.	Colt credit.	Net cost per head.
Southern	$34.30	$6.06	$4.77	$0.05	$0.73	$6.21	$8.50	$3.00	$1.64	$55.98
Western	20.72	5.44	4.63	.02	.24	5.67	5.40	1.50	2.98	37.64
Northern	35.72	11.07	4.17	.05	.83	6.73	5.95	5.00	.96	58.86
All	29.80	7.42	4.53	.04	.58	6.17	6.53	3.09	1.92	50.66

TABLE 33.—*1923 cost per head of keeping work stock.*

Area.	Feed.	Chores.	Harness.	Shoeing.	Veterinary.	Interest.	Depreciation.	Manure credit.	Colt credit.	Net cost per head.
Southern	$43.98	$6.06	$4.77	$0.05	$0.73	$5.55	$7.59	$3.00	$1.64	$64.09
Western	25.97	5.44	4.63	.02	.24	5.07	4.82	1.50	2.98	41.71
Northern	37.38	11.07	4.17	.05	.83	6.01	5.31	5.00	.96	58.86
All	35.27	7.42	4.53	.04	.58	5.51	5.84	3.09	1.92	54.13

COST PER FARM OF KEEPING WORK STOCK.

Table 34 shows the average annual cost per farm of keeping work stock on farms of different sizes. For all farms the average cost for the year was $541.

TABLE 34.—*Cost per farm of keeping work stock on farms of different sizes, 1921.*

Size of farm (crop acres).	Southern area.		Western area.		Northern area.	
	Number of farms.	Cost per farm.	Number of farms.	Cost per farm.	Number of farms.	Cost per farm.
Less than 160	20	$330	0	.....	10	$332
160 to 239	36	542	5	$410	27	417
240 to 319	34	614	17	406	46	461
320 to 399	18	667	18	395	29	556
400 to 479	7	986	19	363	7	793
480 to 639	5	743	22	670	8	1,016
640 to 799	.....	.....	14	578	.....	.....
800 and over	.....	.....	12	843	.....	.....
Total and average	120	583	107	522	127	517

COST OF HORSE LABOR.

The cost per hour of horse labor was determined for each farm by dividing the total cost of keeping the work stock by the total number of hours of work done by the horses owned on that farm during the year. For all farms the average cost per hour was 17 cents. In the southern area the cost was 22 cents per hour, in the western area 18 cents, and in the northern area 13 cents. There were wide variations in both the cost per head of keeping the work stock and the hours of work per head, and consequently there were wide variations in the cost of horse labor. On 68, 19 per cent of the 354 farms, the cost was less than 10 cents, and on 78, 22 per cent, it was 20 cents or more.

Table 35 shows the cost per head of keeping the work stock and the cost per hour of horse labor on farms where they did different amounts of work per head. In general the cost per head of keeping the work stock was greatest on the farms where they were utilized most fully, but the cost did not decrease in proportion to the amount of work done. On the average the cost per hour of horse labor was least on the farms where the horses did the most work per head. These figures should not be interpreted to indicate that a tractor owner should use his horses on unnecessary work or on work for which the tractor could be used to better advantage just for the sake of reducing the cost per unit of work, but they do show the importance of reducing the number of work stock to a minimum and thus decreasing both the total cost per year of keeping them and the cost per hour of horse labor.

TABLE 35.—*Relation of hours of work per head to cost per year of keeping work stock and cost per hour of horse labor.*

Hours per head.	Southern area.			Western area.			Northern area.		
	Number of farms.	Cost per head.	Cost per hour.	Number of farms.	Cost per head.	Cost per hour.	Number of farms.	Cost per head.	Cost per hour.
Less than 200	13	$74	$0.58	16	$42	$0.37	0	.....	.....
200 to 399	40	71	.33	44	51	.18	16	$54	$0.16
400 to 599	31	75	.15	32	60	.13	63	70	.14
600 to 799	26	89	.13	10	56	.09	38	78	.12
800 and over	10	102	.11	5	57	.06	10	62	.07
Total and average	120	76	.22	107	50	.18	127	69	.13

COST OF USING TRACTORS.

Each tractor owner reported the first cost of his machine and estimated the total length of its useful life. The annual depreciation was determined by dividing the first cost of the tractor by its estimated life. The cash outlay for repair parts and expert labor during the year, and the amount of time spent by the owner or regular farm labor in repairing or overhauling the machine were obtained. Interest was charged at 8 per cent on the average investment. Table 36 shows the average annual charges for depreciation, interest, repairs, and upkeep of the tractors of different sizes.

The total annual cost of these items for each tractor was divided by the number of hours the tractor was used during the year and to this was added the cost of the fuel and oil used per hour to obtain the cost per hour of work. The cost per acre for each operation

was obtained by multiplying the cost per hour by the number of hours required per acre. No charge was made for shelter, taxes, or insurance, but these items would amount to only a small percentage of the total cost.

TABLE 36.—*Average annual charges for depreciation, interest, repairs, and upkeep of tractors of different sizes, 1921.*

Size of tractor.	Number.	Annual charge per tractor for—					
		Depreciation.	Interest.	Repair parts.	Expert labor.	Farm labor for repairs.	Total.
2-plow	88	$170	$43	$36	$12	$6	$267
3-plow	207	242	68	50	10	8	378
4-plow	40	311	88	87	13	9	508
Over 4-plow	19	371	112	80	5	8	576
All	354	239	66	53	11	7	376

First cost.—The machines used by 36 of the tractor owners had been purchased second hand, and the reports on these machines are not included in most of the following tables and discussions concerning the various items of cost. The average first cost of the two-plow tractors which had been purchased new was $948, of the three-plow tractors $1,482, of the four-plow tractors $2,023, of the five-plow and larger tractors $2,505, and of all tractors $1,473. Most of these tractors had been purchased at prices considerably higher than now prevail (1924). (See p. 37.)

Life.—The average estimated life of the 318 machines was 6.8 years. An owner's estimate of the life of his machine depended not only on its condition at the time and the work which he expected to do with it in the future, but also, to a considerable extent, on his opinion as to when it would be more profitable to discard it than to spend more time and money for repairs. Consequently there were wide variations in these estimates.

Table 37 shows the average estimated life for machines of different sizes and ages. Evidently there was no tendency for the men who had owned their machines for a short time to overestimate the length of time they would last, since for all except the large sizes the averages for the machines which had been in use 14 months or less were lower than the averages for all machines.

TABLE 37.—*Estimated life of tractors of different ages.*

Age of tractors (months).	2-plow tractors.		3-plow tractors.		4-plow tractors.		5-plow and larger.	
	Number.	Average estimated life.	Number.	Average estimated life.	Number.	Average estimated life.	Number.	Average estimated life.
		Years.		*Years.*		*Years.*		*Years.*
14 and less	33	5.3	76	6.6	13	5.6	8	7.5
15 to 26	26	6.3	63	7.7	11	7.0	2	6.0
27 to 38	16	7.9	32	6.7	9	8.0	3	4.7
39 and over	4	8.0	18	7.6	3	9.7	1	10.0
Total and average	79	6.3	189	7.1	36	6.9	14	6.9

Repairs and upkeep.—The age of a tractor has considerable influence on the annual cost for repairs and upkeep and these costs for two-plow, three-plow, and four-plow tractors of different ages are summarized in Table 38. It is seen that in general the cost for the older tractors was greater than for the newer ones.

In determining the repair and upkeep cost for each tractor, repair parts and expert labor were charged at the cash cost and farm labor, that is, the labor of the owner, members of the family, or the regular hired help, at 20 cents per hour. The number of tractors on which there was no cost for any of the three items during the year covered by the investigation is shown in the last three columns of the table. In all, some repair parts had been purchased during the year for 266 of the 318 machines, some expert labor had been used on 91, and some farm labor on 284.

A considerably larger percentage of the tractors which had been in use a short time than of the older ones required no cash expense for repairs during the year.

TABLE 38.—*Annual repair and upkeep costs of tractors of different ages, 1921.*

Age of tractors (months).	Number.	Average expense per tractor for—				Number of tractors without cost for—		
		Parts.	Expert labor.	Farm labor.	Total.	Parts.	Expert labor.	Farm labor.
2-plow:								
14 and less	33	$20	$12	$4	$36	8	22	7
15 to 26	26	43	15	7	65	4	20	4
27 to 38	16	66	12	6	84	2	13	1
39 and over	4	6	5	4	15	0	3	0
3-plow:								
14 and less	76	29	11	7	47	19	57	4
15 to 26	63	59	9	8	76	7	48	7
27 to 38	32	53	12	8	73	5	20	3
39 and over	18	91	8	6	105	2	12	1
4-plow:								
14 and less	13	97	8	6	111	2	12	3
15 to 26	11	90	9	10	109	0	7	1
27 to 38	9	86	29	13	128	1	2	1
39 and over	3	85	0	10	95	0	3	0

Fuel and oil.—Table 39 shows the amounts of fuel and oil used per year and per hour for the drawbar work done on the home farm by the machines of different sizes. The average tractor used 660 gallons of fuel per year for drawbar work, 49 per cent of which was gasoline and 51 per cent kerosene. The average cost per gallon of the gasoline used during the year covered by the investigation was 25 cents, kerosene, 17 cents, and lubricating oil, 89 cents. These are somewhat higher than present prices in the same territory. (See p. 31.)

TABLE 39.—*Fuel and oil used per year and per hour for drawbar work on home farm by tractors of different sizes.*

Size of tractor.	Number.	Drawbar work per year.	Fuel per year.			Oil per year.	Fuel per hour.	Oil per hour.
			Gasoline.	Kerosene.	Total.			
		Hours.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
2-plow	88	309	270	275	545	51	1.8	0.16
3-plow	207	296	310	339	649	43	2.2	.15
4-plow	40	334	454	439	893	62	2.7	.19
Over 4-plow	19	268	465	374	839	63	3.1	.24
Total and average	354	302	324	336	660	48	2.2	.16

The amount of fuel and oil used per acre for the different operations by machines of different sizes is shown in Table 40. Although the larger machines required greater amounts of fuel and oil per hour, there should be no great difference in the amounts required per acre for the different sizes if implements which provide full loads are used. The table shows that there was little difference in the average number of gallons of fuel and oil used per acre for plowing with the different sizes. On nearly all of the other operations, however, the small machines used the least fuel and oil per acre. In a large measure this was due to the fact that the implements used with the larger tractors did not always provide full loads for them.

TABLE 40.—*Fuel and oil requirements per acre for different operations.*

Operation.	2-plow.		3-plow.		4-plow.		Over 4-plow.		All.	
	Fuel.	Oil.	Fuel.	Oil.	Fuel.	Oil.	Fuel.	Oil.	Fuel.	Oil.
	Gals.	*Gals.*	*Gals.*	*Gals.*	*Gals.*	*Gals.*	*Gals.*	*Gals.*	*Gals.*	*Gals.*
Spring plowing	2.15	0.21	2.10	0.15	2.20	0.20	(1)	(1)	2.13	0.13
Fall plowing	2.28	.21	2.18	.15	2.01	.15	2.03	0.16	2.16	.16
Listing	1.05	.09	1.32	.08	(1)	(1)	.....	.....	1.24	.08
Sledding	1.12	.01	1.25	.08	(1)	(1)	.....	.....	1.18	.09
Disking plowed ground	.96	.06	.99	.06	(1)	(1)	(1)	(1)	.98	.06
Disking unplowed ground	.80	.09	1.04	.07	.97	.09	(1)	(1)	1.01	.08
Harrowing	.46	.04	.49	.03	(1)	(1)	.....	.....	.48	.03
Drilling	.71	.06	.70	.05	.77	.04	.69	.05	.71	.05
Grain binder	.80	.06	.81	.06	.78	.06	(1)	(1)	.81	.06
Combine	(1)	(1)	.89	.06	(1)	(1)	(1)	(1)	.89	.06
Listing corn	1.11	.09	1.34	.09	(1)	(1)	.....	.....	1.25	.09

[1] Less than 10 tractors.

COST PER YEAR AND PER HOUR OF USING TRACTORS FOR DRAWBAR WORK.

Table 41 shows the average cost per year and per hour of using tractors of different sizes for drawbar work on the home farm in each area. For the entire 354 machines the average cost per year was $484, or $1.60 per hour. The average cost per year varied in the different areas in accordance with the amount of work done per year, and since in general the cost per hour was least for the machines which did the most work (Table 42) the average cost per hour was greatest in the northern area.

The costs per hour on different farms using tractors of the same size showed wide variations because of differences in annual depreciation and repair charges, amount of work done during the year, and the amounts of fuel and oil used.

EFFECT OF HOURS OF USE PER YEAR ON COST OF USING TRACTORS.

Table 42 shows the cost per hour of using two-plow, three-plow, and four-plow tractors, that were used for different amounts of work per year. The annual depreciation, repair, and interest charges did not increase in proportion to the amount of work done with the tractors, and consequently the cost per hour was least for the machines which did the greatest amount of work.

These differences are reflected directly in the cost per acre or per bushel of producing crops and show how the man whose farm is so organized and managed that he obtains large use from his equipment

can produce at low cost. A farmer should not, of course, endeavor to use his equipment as many days or hours during the year as possible just for the sake of reducing the cost per day or hour, for even though the cost per day or hour decreases with increased use the total cost per year must increase.

TABLE 41.—*Cost per year and per hour for using tractors of different sizes for drawbar work.*

Size of tractor.	Number.	Drawbar work per year.	Total cost per year for drawbar work.	Cost per hour for drawbar work.
		Hours.		
Southern area:				
2-plow	28	360	$447	$1.24
3-plow	73	368	599	1.63
4-plow	16	384	720	1.88
Over 4-plow	3	160	683	4.27
Total	120	365	588	1.61
Western area:				
2-plow	34	344	426	1.24
3-plow	49	350	512	1.46
4-plow	14	350	664	1.90
Over 4-plow	10	368	673	1.83
Total	107	350	530	1.49
Northern area:				
2-plow	26	209	304	1.46
3-plow	85	203	356	1.75
4-plow	10	233	487	2.09
Over 4-plow	6	127	377	2.97
Total	127	203	357	1.76
All areas:				
2-plow	88	309	397	1.28
3-plow	207	296	479	1.62
4-plow	40	334	642	1.92
Over 4-plow	19	268	617	2.30
Total	354	302	484	1.60

The table indicates that since the amount of work done has only a slight effect on the annual charges for depreciation, repairs, and interest charges, a farmer should give prime consideration to the cost of fuel and oil and not to the total cost per hour of use when deciding whether to use his tractor for operations where it is of doubtful value.

TABLE 42.—*Effect of hours of use per year on cost of using tractors.*

Hours of use per year.	Number of tractors.	Average hours of use per year.	Hours of drawbar work per year.	Cost per year for drawbar work.	Cost per hour for drawbar work.
2-plow:					
Less than 200	16	160	147	$263	$1.79
200 to 399	42	280	258	365	1.41
400 to 599	24	494	417	469	1.12
600 and over	6	709	609	609	1.03
3-plow:					
Less than 200	47	134	116	357	3.08
200 to 399	76	298	232	429	1.85
400 to 599	56	494	399	555	1.39
600 and over	28	744	568	665	1.17
4-plow:					
Less than 200	4	115	96	340	3.54
200 to 399	13	309	252	580	2.30
400 to 599	15	496	379	687	1.81
600 and over	8	748	503	809	1.61

COST OF USING TRACTORS IN 1922 AND 1923.

The prices of tractors declined considerably in 1921 and 1922, and prices of fuel and oil were somewhat lower during 1922 and 1923 than during the year covered by the investigation. Tables 43 and 44 show the approximate average cost in 1922 and 1923 of using similar tractors purchased at prices current in 1922 and 1923 and doing the same amount of work as was done by the machines on the farms surveyed. The depreciation figures shown in each table were obtained by dividing the first cost during the year by the average estimated life as obtained from the tractor owners. The interest charge was computed at 8 per cent of the first cost. The cost for repairs and upkeep are the same as the 1921 costs obtained from the farmers. The approximate tank-wagon prices to farmers of gasoline, kerosene, and lubricating oil in these areas during the year ended August 1, 1922, were 21 cents, 12 cents, and 70 cents per gallon respectively; in 1923, 20 cents, 11 cents, and 67 cents respectively. The costs for fuel and oil, as shown in Tables 43 and 44, were obtained by charging the amounts used for drawbar work in 1921 at the above prices.

TABLE 43.—*1922 cost of using tractors.*

	Southern area.	Western area.	Northern area.	All farms.
First cost (1922)....dollars..	1,100	1,100	1,000	1,065
Estimated life....years..	6.8	6.3	7.4	6.8
Annual depreciation....dollars..	162	175	135	157
Annual interest....do....	50	51	45	49
Annual cost of repairs and upkeep....do....	106	46	57	71
Total....do....	318	272	237.00	277
Per cent drawbar work is of total	83	83	73	80
Annual cost of depreciation, interest, and repairs for drawbar work....dollars..	264	226	173	222
Annual cost of fuel for drawbar work:				
Gasoline....do....	112	72	23	68
Kerosene....do....	36	45	40	40
Cost of lubricating oil for drawbar work....do....	40	38	24	34
Cost per year for drawbar work....do....	452	381	260	364
Cost per hour for drawbar work....do....	1.24	1.09	1.28	1.21
Cost of drawbar work, 1922 percentage of 1921	77	73	73	75

TABLE 44.—*1923 cost of using tractors.*

	Southern area.	Western area.	Northern area.	All farms.
First cost (1923)....dollars..	1,100	1,075	960	1,045
Estimated life....years..	6.8	6.3	7.4	6.8
Annual depreciation....dollars..	162	171	130	154
Annual interest....do....	50	50	44	48
Annual cost of repairs and upkeep....do....	106	46	57	71
Total....do....	318	267	231	273
Per cent drawbar work is of total	83	83	73	80
Annual cost of depreciation, interest, and repairs for drawbar work....dollars..	264	222	169	218
Annual cost of fuel for drawbar work	106	69	22	65
Gasoline....do....	33	42	37	37
Kerosene....do....	38	36	23	32
Cost of lubricating oil for drawbar work....do....	441	369	251	352
Cost per year for drawbar work....do....	1.21	1.05	1.24	1.16
Cost per hour for drawbar work	75	17	70	73
Cost of drawbar work, 1923 percentage of 1921				

RELIABILITY OF TRACTORS.

The reliability of a tractor has a decided effect on its profitableness. To obtain definite information on this point each farmer visited was asked how many days during the year his tractor was out of running order, and for how many days it was needed while out of order.

On the average the 354 tractors were out of running order 10.6 days, but were needed for an average of only 2.1 days of work during that time. Some of them had broken down near the end of the season and had not been repaired immediately, and some had been taken down for repairs or overhauling and allowed to remain out of running order for considerable periods when not needed. Two hundred and twelve, or 60 per cent of the total, had been out of order during the year, but 59 of the 212 had not been needed for any work while out of order. The remaining 153 had been needed for an average of about 5 days of work while out of commission.

No great difference in reliability was shown among the different sizes. About 61 per cent of the two-plow tractors, 57 per cent of the three-plow, and 50 per cent of the four-plow and larger machines were not out of order when needed at any time during the year. The age of the tractors likewise had no marked influence on their reliability. Of 130 machines which had been purchased new and which had been in use 14 months or less, 72, or 55 per cent, had not been out of order when needed, and the remaining 58 had been out of order when needed for an average of 4.6 days. Of 86 machines which had been purchased new and which had been used 27 months or more, 54, or 63 per cent, had always been ready when needed and the remaining 32 had been out of order when needed for 6.1 days on the average.

The number of days tractors were out of order when needed in each area is shown in Table 45. In the southern area some time had been lost by about 60 per cent of the machines, in the western area by 40 per cent, and in the northern area by about 30 per cent. Considering only those which had been out of order when needed, the time lost by each machine amounted on the average to 5 days, 4.7 days, and 4.5 days in the southern, western, and northern areas, respectively.

TABLE 45.—*Days per year tractors were out of order when needed.*

Area.	Number of tractors.	Number out of order when needed for—					Average.	
		0 days.	1 or 2 days.	3 or 4 days.	5 or 6 days.	7 days or more.	For all tractors.	For those out of order 1 day or more.
Southern	120	47	34	16	6	17	3.1	5.0
Western	107	64	12	11	11	9	1.9	4.7
Northern	127	90	17	8	5	7	1.3	4.5
Total	354	201	63	35	22	33	2.1	4.7

ANNUAL COST OF POWER FOR DRAWBAR WORK.

On the average farm the cost of keeping work stock during the year was $541 and the cost of using the tractor for drawbar work was $484. Thus the total annual cost of power for drawbar work was

$1,025, or $2.91 per crop acre. The cost of using the tractor was 47 per cent of the total. Table 46 shows these items for the farms of different sizes in each area. In the southern and western areas the cost of using the tractor was 50 per cent and in the northern area 41 per cent of the total cost.

While the total cost of power increases with the size of the farm in each area the average cost per crop acre for power was higher on the small farms than on the large ones. In general both tractors and work stock were utilized more fully on the larger farms (see Tables 11 and 23) and since on the average the cost per unit of work done with either form of power decreased as the amount of work done annually increased, the total cost of power was proportionally less on the large farms. Figure 14 shows graphically the cost of power on farms of different sizes.

On many of the farms more work stock than necessary were still being kept and the cost per farm of keeping work stock would have been reduced by an average of about $115 (see p. 47) if they had been sold. Likewise, if the tractor work had been done with machines purchased at current prices the cost would, on the average, be something like 25 per cent lower than the figures shown.

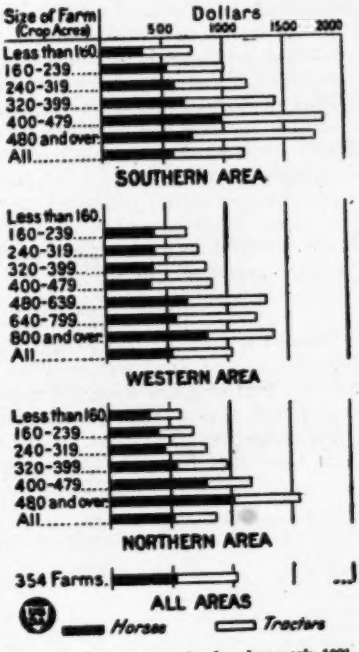

FIG. 14.—Cost of power for drawbar work, 1921.

TABLE 46.—*Cost of power for drawbar work on farms of different sizes, 1921.*

Size of farm (crop acres).	Number of farms.	Average size (crop acres).	Cost of keeping work stock.	Cost of tractor for drawbar work.	Total cost per year.	Cost per crop acre.	Per cent tractor cost is of total.
Southern area:							
Less than 160	20	130	$350	$407	$757	$5.82	54
160 to 239	36	202	542	477	1,019	5.04	47
240 to 319	34	278	614	596	1,210	4.35	49
320 to 399	18	359	667	769	1,436	4.00	54
400 to 479	7	415	986	855	1,841	4.44	46
480 and over	5	541	742	1,022	1,764	3.26	58
Total and average	120	263	583	588	1,171	4.47	50
Western area:							
160 to 239	5	219	410	256	666	3.04	38
240 to 319	17	281	406	366	772	2.75	47
320 to 399	18	350	395	433	828	2.37	52
400 to 479	19	441	362	521	883	2.00	59
480 to 639	22	555	670	658	1,328	2.39	50
640 to 799	14	703	578	667	1,245	1.77	54
800 and over	12	1,054	843	547	1,390	1.32	39
Total and average	107	516	522	520	1,042	2.02	50
Northern area:							
Less than 160	10	135	333	260	593	4.39	44
160 to 239	27	202	417	279	696	3.45	40
240 to 319	45	278	461	345	806	2.92	43
320 to 399	29	369	556	422	978	2.65	43
400 to 479	7	438	793	373	1,166	2.66	32
480 and over	8	585	1,016	550	1,566	2.68	35
Total and average	127	299	517	357	874	2.92	41

VARIATIONS IN COST.

There were wide variations in the cost of power on individual farms, the total cost of power for drawbar work on some farms having been twice as great as on others of the same size and type. Figure 15 shows the variations in each area. In this figure each dot represents one farm, the vertical distance from the base line represents the combined cost of keeping work stock and of using the tractor for drawbar work, and the horizontal distance from the left represents the crop area of the farm. The heavy lines connect the points representing the average cost on farms of different sizes as shown in Table 46.

In some cases the death or injury of some of the work stock caused heavy depreciation and a high cost of power for the year; on other farms high repair costs for the tractors were responsible. It is evident, however, that the proper management of tractor and work stock and the judicious choice of sources of power for different operations would have resulted in a considerable decrease in the cost of power for the year on many of the farms.

SOME FARMS WITH LOW COSTS FOR POWER.

The story of an individual farm on which the costs indicate an efficient use of power should be of value in showing how power can be obtained at a low cost. Table 47 is a summary of the data incident to the cost of power for drawbar work on six such farms, two in each of the three areas. The relative costs for power on these farms as compared with the other farms in the same areas are shown in Figure 15.

TABLE 47.—*Farms with low costs of power for drawbar work.*

	Southern area.		Western area.		Northern area.	
	Farm No. 1.	Farm No. 2.	Farm No. 1.	Farm No. 2.	Farm No. 1.	Farm No. 2.
Crop area.....acres..	146	392	740	1,080	145	622
Area in wheat.....do....	125	295	275	900	85	450
Area in corn.....do....	0	30	80	0	60	120
Size of tractor.....plows..	2	3	3	3	3	4
Date of purchase of tractor.....	July 1919.	Aug. 1918.	Mar. 1920.	June. 1920.	Aug. 1918.	Apr. 1920.
Number of work stock.....	2	8.5	10	20	4	12
Tractor work per year:						
Drawbar.....hours..	342	242	480	834	123	208
Belt.....do....	5	120	0	20	75	228
Custom.....do....	0	180	140	0	0	355
Total.....do....	347	542	620	854	198	830
Horse labor equivalent of tractor (drawbar) work..do..	2,013	2,638	4,446	4,910	716	4,026
First cost of tractor.....dollars..	760	1,200	1,695	1,760	1,800	2,505
Estimated total life.....years..	8	8	5	10	10	6
Annual cost of repairs and upkeep.....dollars..	22	116	50	5	7	237
Fuel per year for drawbar work:						
Gasoline.....galls..	571	578	6	67	3	10
Kerosene.....do....			1,274	844	262	700
Oil per year for drawbar work.....do....	33	48	98	44	16	30
Cost of using tractor for drawbar work:						
Per year.....dollars..	39	331	462	432	202	373
Per hour.....do....	0.99	1.37	0.94	0.81	1.64	1.40
Total value of work stock.....do....	55	650	612	2,100	400	1,433
Annual feed consumption per head:						
Grain.....pounds..	1,600	1,806	360	600	2,800	1,470
Hay and roughage.....do....	3,000	2,340	4,000	6,000	5,000	1,660
Cost of keeping work stock per year.....dollars..	115	601	392	740	261	794
Cost per head of keeping work stock per year....do....	58	71	39	37	65	66
Horse labor per year.....hours..	1,765	6,968	3,820	7,160	2,317	6,906
Horse labor per head.....do....	882	822	382	359	579	575
Cost per hour of horse labor.....cents..	7	9	10	10	11	12
Horse labor equivalent of total drawbar work..hours..	3,778	9,606	8,266	12,070	3,033	10,922
Proportion of total drawbar work done with tractor.....per cent..	53	28	54	41	23	37
Total cost per year of power for drawbar work (tractor and horse).....dollars..	454	982	854	1,172	463	1,167
Cost per crop acre of power for drawbar work....do....	1.32	2.38	1.15	1.08	3.19	1.86

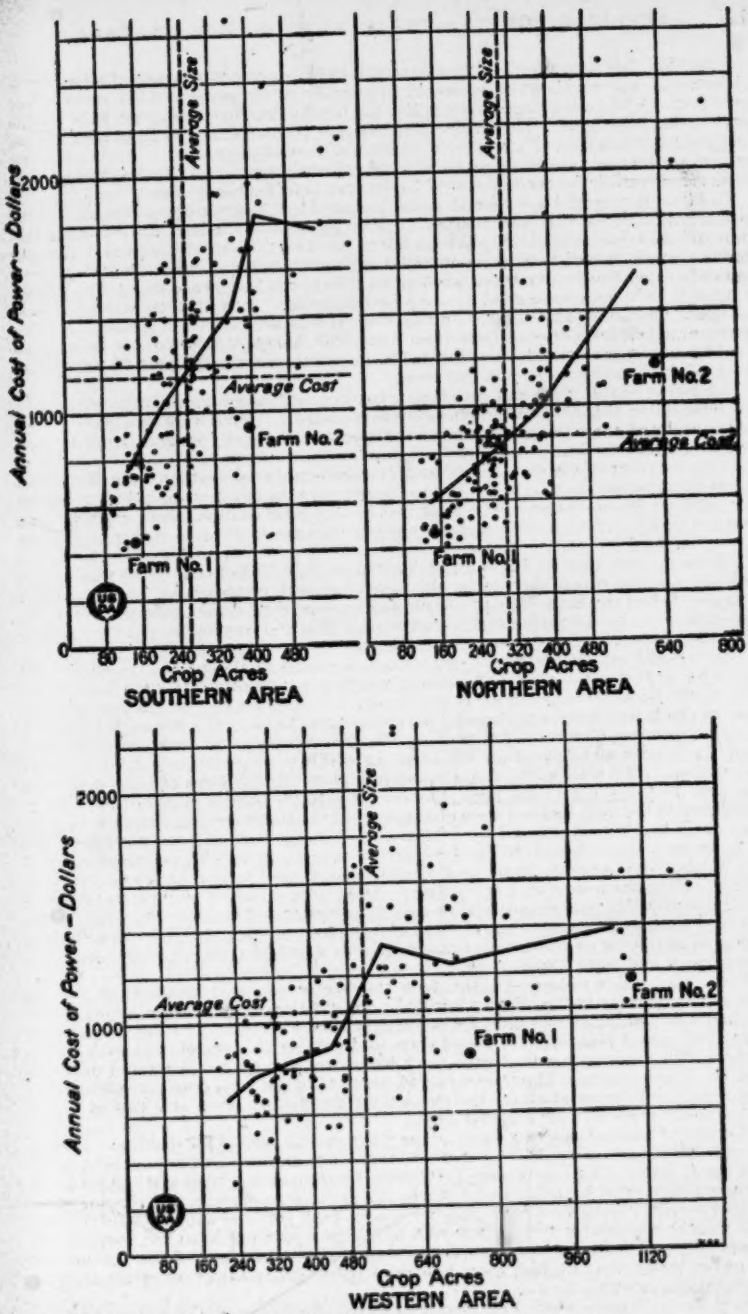

FIG. 15.—Variation in total cost of power per farm for all the areas.

Farm No. 1, southern area.—This farm of 146 crop acres was operated with a two-plow tractor and two head of workstock at a total cost for power of $454, or $1.32 per crop acre. The power furnished by the tractor for drawbar work cost $339 for the year, or $0.99 per hour. This low cost is the result of comparatively small investment, few repairs, an estimated life of eight years, and normal use of fuel and oil. The low investment in the work stock and their full utilization on all of the two-horse operations is responsible for the low cost of 7 cents per hour for horse labor.

The tractor plowed 85 acres and listed and sledded 40 acres of the wheat ground, disked and harrowed (in combination) the oats ground (11 acres), drilled the wheat and oats, and harvested them with an 8-foot binder. The horses plowed 4 acres for Sudan grass, harrowed three and one-half days in preparing the wheat ground, planted and cultivated 6 acres of corn, made 4 acres of hay, stacked 80 acres of grain, headed 6 acres of kafir, and were used 4½ days for threshing. A third horse was purchased for use in harrowing and listing, and sold when this work was completed. Had all of the drawbar work on this farm been done with horses, 3,778 hours of horse labor would have been required. On this basis the tractor work represents 53 per cent of the total drawbar work done on this farm.

The owner of this farm had just begun farming in that community, consequently no changes due to the use of the tractor were recorded. "More work in a given time" was considered the chief advantage of the tractor and "first cost and depreciation" the chief disadvantage.

Farm No. 2, southern area.—This farm is considerably larger than farm No. 1 (see Table 47), and an average of 8.5 head of work stock in addition to a 3-plow tractor was used in its operation. The total cost of power for drawbar work represents an increase of 205 per cent, with a corresponding increase of 270 per cent in crop acres over farm No. 1.

The tractor was used for 242 hours of drawbar work, or 28 per cent of the total. The depreciation and repair charges for the year were both considerably higher than on farm No. 1, but the large amount of belt and custom work done reduced the proportion of these costs chargeable to drawbar work so that the cost for the year was practically the same as for the tractor on farm No. 1.

The cost of keeping work stock on this farm includes $100 depreciation for the loss of one horse during the year, and interest on a larger investment than on farm No. 1. The yearly horse labor per head is practically the same on the two farms, although more of the heavy work was done by horses on farm No. 2. The horses did 50 acres of spring plowing, 60 acres of fall plowing, 37 acres of listing, 335 acres of seeding, and drew the binder and header on 335 acres, in addition to performing 1,568 hours of other labor. The tractor did 225 acres of fall plowing, 215 acres of harrowing, and was used for threshing on the farm, besides doing 8,000 bushels of custom threshing.

The size of the farm had not been changed since the purchase of the tractor, but the work stock had been decreased by 5.5 head. The horses had all been purchased and no colts were being raised at the time of the investigation. Three months less of family labor was used during the year than had been used before the tractor was purchased. "Saving horses in hot weather," and "first cost and depreciation" were thought to be the greatest advantage and disadvantage of the tractor. The owner believed that in 1921 an increased yield of 5 bushels of wheat per acre was directly traceable to the use of the tractor through greater depth of plowing, better seed bed preparation, and more timely work.

Farm No. 1, western area.—On this farm the tractor was used for a greater variety of work than on any of the others described. In addition to 103 hours of plowing and 137 hours of disking it was used for seeding 565 acres of grain, cutting 155 acres of grain, listing and planting 65 a res of corn, and cutting 25 acres of corn with a corn binder. The seeding was done with two 8-foot drills, and a 2-row lister and drill was used for planting corn. The tractor did 54 per cent of the total drawbar work on the farm, which is 8 per cent above the average for the western area, at a cost of 89 per cent of the average cost for drawbar work.

The tractor was out of order for six days when it was needed for disking. During the year $40 for new parts, $5 for expert labor and two and one-half days of farm labor were spent on it. The horses were fed 2 tons of roughage per head and a light grain ration supplemented by five months of wheat, four months of grass, and three months of night pasture during the year. The low cost for feed, together with a $50 colt credit, were largely responsible for the low cost of $39 per year per head for keeping the horses. Two work horses had been disposed of after the purchase of the tractor and the owner stated that he had made a marked reduction in the grain ration allowed the remaining horses.

Farm No. 2, Western area: This farm was by far the largest one of the six and the total cost of power for drawbar work was naturally greatest, yet the cost per crop acre was only $1.08, which is less than on any of the other farms. Five hundred and

fifty-four hours of work with $5 annual repairs and an estimated life of 10 years resulted in the low cost of 81 cents per hour for using the tractor for drawbar work. Twelve mares, six geldings and two mules were kept on this farm. The mares were kept primarily to raise colts and the operator considered that only 12 head of work stock in addition to the tractor were necessary for the proper operation of the farm. The mares had produced six mule colts during the year and the colt credit for the year reduced the cost of keeping horses by $210. The low grain ration fed was another factor contributing to the low cost ($37 per year) of keeping work stock.

In addition to fall plowing, disking, drilling, and cutting cane with a grain binder, the tractor was used 11 days for harvesting grain with a combine. Large horse-drawn equipment was used on this farm. For plowing, a three-bottom disk plow and a three-bottom moldboard plow, each drawn by six horses, were used. Two-row listers were used and a 14-foot header, each of which was drawn by six horses.

The owner estimated that the grain ration per head of the work stock had been reduced 50 per cent and roughage 20 per cent after the purchase of the tractor and stated that he could raise more colts since the tractor was doing most of the heavy work.

Farm No. 1, Northern area: Twenty-three per cent of the total drawbar work was done with the tractor on this farm, which is the smallest farm of the six. Eighty-five acres of wheat and 60 acres of corn were the only crops raised. The tractor plowed 30 acres for wheat, disked the remainder of the wheat ground, drilled 30 acres, and cut the entire 85 acres with a 7-foot binder. The horses seeded 55 acres of wheat with one-horse drills in the standing corn, listed, and cultivated (three times) 60 acres of corn, and were used for stacking grain, husking corn from the standing stalks, and for hauling wheat from the thresher to the grain bin. Four horses were needed (the same number as was on hand) to do the work and one colt was being raised.

The work stock were fed 50 bushels of corn and 2½ tons of roughage per head per year supplemented by three months of grass and four months of stubble and stalk pasture. The cost per head of keeping the horses was $4 below the average for the area and the hours of horse labor 13 above the average. The cost per crop acre for power, $3.19, was the highest of the six farms because of the small size of the farm. Likewise the cost per hour of using the tractor, $1.64, was highest on this farm, despite a low depreciation and few repairs. Yet when the size of the farm is considered the cost of power was very low. (See Fig. 15.)

In addition to the drawbar work the tractor was used two and one-half days for shelling corn and five days for shredding fodder. It had displaced two head of work stock. The owner believed it had been responsible for an increase of 5 bushels per acre in his yield of wheat in 1920. He was using it as his primary source of power and considered it a profitable investment.

Farm No. 2, northern area: The horses did all of the drawbar work on this farm except 330 acres of fall plowing, and harvesting 475 acres of grain. These two operations however, required 37 per cent of the total power for drawbar work. Of the total hours of work per year done with the tractor, 31 per cent was drawbar, 28 per cent was belt, and 31 per cent was custom work. Hence this four-plow tractor follows the general rule that the larger tractors are used for a greater amount of belt work than the smaller ones. Three 7-foot grain binders were pulled on this farm at one time at a cost for power and man labor of 39 cents per acre compared with 87 cents per acre for all farms where tractors were used for this work. The tractor was overhauled between busy seasons at a total cost of $237 of which $50 was for expert labor.

Twelve head of work stock, the same number as the operator stated he needed, were kept, and four colts were being raised. A reduction in both grain and the hay ration of 30 per cent per head and an increase of 10 per cent in pasture had been made since the purchase of the tractor. When farming with horses only, 18 head had been kept for 480 crop acres, one for every 27 crop acres. At the time of the investigation 142 additional crop acres were being farmed with 12 head of work stock, one for each 52 crop acres.

CHANGES AFTER PURCHASE OF TRACTOR.

For each farm visited a record was obtained of any changes in size of farm, in the number of work stock and in the amount of feed consumed per head, in the amount of family and regular hired labor used or in tillage practice which had been made since the purchase of the tractor. From this and other information obtained the change in the cost of power and labor due to the use of the tractors and the change in investment due to their purchase were computed.

CHANGE IN SIZE OF FARM.

Table 48 shows the changes in size of the farm in the different areas. Twenty-seven of the 354 tractor owners had purchased their machines when they started farming and the reports of these men are not included. Of the 327 farms, 191, or 58 per cent, had not been changed in size, 114, or 35 per cent, had been made larger by an average of 166 crop acres, and the remaining 22 had been decreased by an average of 111 crop acres. For all farms there was an average increase of 50 crop acres after the tractors were purchased. The increase was greatest in the western area, 98 crop acres, and least in the southern area, 18 crop acres. About 40 per cent of the tractor owners in the western and northern areas and only a little over 25 per cent of those in the southern area had increased the size of their farm.

The reports of the Bureau of the Census show that between 1910 and 1920 there had been an average increase of 11 improved acres per farm in the southern area, 230 in the western area, and 16 in the northern area. While the increase in the size of these farms after tractors were purchased was doubtless greater than the increase in the size of all farms during the same time in these areas, it is probable that the tractors were not primarily responsible for the increase, as there was also an average increase of about 45 crop acres on the 85 farms where tractors were not owned. (See Table 64.)

TABLE 48.—*Change in size of farm after purchase of tractors.*

Area.	Total number of farms.	No change in size.		Increased in size.			Decreased in size.			All farms.	
					Average size.			Average size.		Average size.	
		Number.	Average size.	Number.	Before purchase.	1921	Number.	Before purchase.	1921	Before purchase.	1921
			Crop acres.		*Crop acres.*	*Crop acres.*		*Crop acres.*	*Crop acres.*	*Crop acres.*	*Crop acres.*
Southern	118	75	250	31	201	309	10	353	210	245	263
Western	96	52	498	38	318	576	6	367	302	419	517
Northern	115	64	269	45	220	347	6	309	201	232	296
Total	327	191	334	114	247	413	22	344	233	299	349

CHANGES IN WORK STOCK.

Before the tractors were purchased the 327 men had been farming an average of 299 crop acres and keeping 9.8 head of work stock—one for each 30 crop acres. In the southern area there had been one horse for each 26 crop acres, in the western area one for each 34 crop acres, and in the northern area one for each 31 crop acres before the tractors were purchased. These men had been keeping practically the same number of work stock in proportion to the size of their farms before they purchased tractors, as the men who were farming with horses only were keeping in 1921. (See Table 58.) In Table 49 the "work stock per farm if tractors were not used" was determined by dividing the average size (crop acres) of the farms in each area by 26, 34, and 31, respectively. The "work stock per farm, 1921" and "necessary work stock per farm" are the same as given in Table 27. On the average

the 354 men were keeping 3.4 head less than they would have been keeping if they had not owned tractors, and they considered that they needed 5.2 head less, an actual reduction of about 30 per cent and a potential reduction of about 45 per cent. The reduction had been greatest in the western area and least in the northern area.

TABLE 49.—*Displacement of work stock by tractors.*

Area.	Number of farms.	Work stock per farm if tractors were not used.	Work stock per farm, 1921.	Necessary work stock per farm.	Actual reduction per farm.	Potential reduction per farm.
Southern	120	10.1	7.5	5.7	2.6	4.4
Western	107	15.2	10.2	7.4	5.0	7.8
Northern	127	9.6	7.4	6.5	2.2	3.1
Total	354	11.7	8.3	6.5	3.4	5.2

CHANGES IN FEED OF WORK STOCK.

Each man was asked for an estimate of the change in the amounts of grain, hay, and roughage, and pasture consumed per head by the work stock after the tractor was purchased, and it was found that about three-fourths of them had made some change in their feeding practices. The averages of the estimates for each area are given in Table 50. Based on the amount of feed consumed per head by the work stock on the same farms during the year covered by the investigation, the change had amounted on the average to a reduction of about 460 pounds of grain and 210 pounds of hay and roughage per head.

TABLE 50.—*Average of tractor owners' estimates of change in feed per head of work stock after purchase of tractors.*

Area.	Number of Farmers.	Change in annual consumption per head.			Number of Farmers reporting no change.
		Grain.	Hay and roughage.	Pasture.	
		Per cent.	*Per cent.*	*Per cent.*	
Southern	116	−20	+2	+9	30
Western	98	−27	−15	+5	16
Northern	115	−17	−6	+3	32
Total	327	−21	−7	+6	78

CHANGE IN AMOUNT OF LABOR USED.

For each farm the number of months of family labor and of regular hired labor used per year before the tractor was purchased and that used during the year covered by the investigation were obtained. The amount of extra or day labor used was not determined, as on practically all of the farms visited extra labor was employed only during the harvesting and threshing season, and it was not believed that the tractor could have any influence on the amount of such

labor used. Neither were any reductions in the amounts of time actually spent at farm work by the operators of the farms themselves obtained.

For the 327 farms an average of 6.1 months of family and regular hired labor was used during the year of the investigation. This was 0.9 month less than had been used before the tractors were purchased. As stated above, the farms had been increased in size by an average of 50 crop acres. Table 51 shows the changes on the 191 farms which had not been changed in size after the tractors were purchased. Sixty-five, or 34 per cent, of the 191 men had reduced the amount of labor; 116 or 60 per cent, had made no change, and the remaining 10 had increased the amount of labor used. For the entire 191 there had been an average reduction of 1.4 months, and for the 65 farms where the labor had been reduced, an average reduction of 4.1 months. The reduction was greatest in the western area, 2.5 months, and least in the northern area, 0.8 month.

TABLE 51.—*Change in family and regular hired labor after purchase of tractor on 191 farms where size was not changed.*

Area.	Number of farms.	Average size (crop acres).	Months of family and hired labor per farm.			Number of farms where labor was—		
			Before purchase.	1921	Reduction.	Reduced.	Not changed.	Increased.
Southern	75	250	6.6	5.4	1.2	28	45	2
Western	52	498	9.0	6.5	2.5	22	27	3
Northern	64	269	6.5	5.7	.8	15	44	5
Total	191	324	7.2	5.8	1.4	65	116	10

CHANGE IN TILLAGE PRACTICE.

With regard to tillage practice, each farmer was asked (1) whether he was making it a practice since he purchased his tractor to plow a greater percentage of his land and to reduce correspondingly the amount listed or disked without plowing; (2) whether he plowed to a greater depth than formerly; and (3) whether he practiced better seed-bed preparation other than plowing than he did before he purchased his tractor. The replies to these questions are summarized in Table 52.

In all, 215, or 66 per cent, of the 327 reported some change in tillage practice. In the southern and northern areas more men reported deeper plowing than either of the other changes, while in the western area more plowing and less disking and listing was reported by the greatest number.

TABLE 52.—*Change in tillage practice after purchase of tractors.*

Area.	Number of farmers.	Number who reported no change.	Number who reported some change.	Number who plowed greater per cent of land.	Number who plowed deeper.	Number who did better seed-bed preparation other than plowing.
Southern	118	38	80	41	65	50
Western	96	36	60	46	32	36
Northern	115	40	75	44	58	41
Total	[1] 327	112	215	131	155	127
Percentage	100	34	66	40	47	39

[1] The 27 of the 354 farmers interviewed not included in this table started farming with tractors.

CHANGE IN COST OF POWER AND LABOR.

In Table 53 is summarized for each area the average change in the combined cost of power and labor due to the use of the tractor. The cost of using the tractor for drawbar work and of keeping the work stock are shown in Table 46. The "cost of power with horses only" has been obtained by multiplying the average cost per head of keeping the work stock in each area as given in Table 29 by the number of "work stock if tractors were not used" as given in Table 49. The value of the saving in family and regular hired labor was obtained by crediting the reduction in labor on the farms which were not changed in size (Table 51) at $50 per month.

It is seen that for all farms there was an average net increase in the combined cost of power and labor of $206 for the year. If the surplus work stock had all been sold and the cost per head of keeping the remaining ones not increased there would have been an average reduction of about $115 in the annual cost of power. The value of the feed consumed per head by the work stock on these farms where tractors were owned was on the average $4 less than that on the 85 farms where tractors were not owned. If it were assumed that the cost per head of keeping the work stock would have been $4 greater if tractors had not been used a further saving of about $47 per farm would be shown.

TABLE 53.—*Changes in annual cost of power and labor due to use of tractor (averages), 1921.*

	Southern area.	Western area.	Northern area.	All farms.
Cost per farm of power for drawbar work, 1921:				
Tractor	$588	$520	$357	$484
Work stock	583	522	517	541
Total	1,171	1,042	874	1,025
Cost of power with horses only	765	767	662	749
Increase in cost of power due to using tractor	406	275	212	276
Saving in family and regular hired labor (at $50 per month)	60	125	40	70
Net increase in cost of power and labor due to using tractor	346	150	172	206

As shown in Tables 32, 33, and 44, both the cost of using tractors and the cost of keeping work stock were lower in 1922 and 1923 than in 1921. Table 54 compares the average change which would have occurred in the annual cost of power and labor for the years of 1922 and 1923 with the change shown in Table 53 for the year 1921, provided tractors purchased at prices current in 1922 and 1923 had been used. It is seen that if tractors purchased at 1922 prices had been used on these farms during the year of 1922, the average net increase in the cost of power and labor due to using the tractors would have been $123, and if tractors purchased at prices current in 1923 had been used during the year of 1923, the average net increase in cost of power and labor due to using the tractors would have been $98, as compared with the average of $206 for the machines in use at the time of the investigation.

TABLE 54.—*Changes in annual cost of power and labor due to using tractors in 1921, 1922, and 1923.*

	1921	1922	1923
Cost per farm of power for drawbar work:			
Tractor	$484	$364	$332
Work stock	541	415	450
Total	1,025	779	802
Cost of power with horses only	749	586	634
Increase in cost of power due to using tractors	276	193	168
Saving in family and regular hired labor (at $50 per month)	70	70	70
Net increase in cost of power and labor due to using tractor	206	123	98

INCREASE IN INVESTMENT DUE TO PURCHASE OF TRACTOR.

In Table 55 is summarized for each area the average increase in investment due to the purchase of the tractors. In each area this increase had amounted to between $1,300 and $1,400. The cost of the tractors is shown on page 33. The value of the work stock displaced was obtained by crediting the actual reduction in work stock as shown in Table 49 at the average value of all work stock as shown in Table 8.

A record of the number and value of implements for drawbar work which each owner purchased for use with his tractor and the number and value of horse-drawn implements which he had sold was obtained. The averages are shown in Table 55. Practically every man had purchased some special tractor implements but only 23, about 7 per cent of the entire number, had disposed of any of their old horse-drawn implements.

TABLE 55.—*Increase in investment due to purchase of tractor.*

Item.	Southern area.	Western area.	Northern area.	All farms.
Cost of tractor	$1,423	$1,524	$1,327	$1,419
Cost of field implements for tractor	222	265	278	255
Total	1,645	1,789	1,605	1,674
Value of work stock displaced	260	460	242	340
Value of horse-drawn implements sold	3	4	2	3
Total	263	464	244	343
Net increase in investment	1,382	1,325	1,361	1,331

FARMS ON WHICH NO CHANGES WERE MADE AFTER PURCHASE OF TRACTORS.

As shown in Table 51, only 65 of the 191 men who had not changed the size of their farms had reduced the amount of labor used. It was found also that only 89 of these 191 had reduced the number of work stock kept. Ninety-one were still keeping the same number of work stock, and 11 were keeping more than before the tractors were purchased. Seventy-three of these 102 who were keeping the same or greater number of work stock on the same acreage had not reduced the amount of family or regular hired labor used. Ten of the 73 were using more labor than formerly. Some of these farms where there

was no reduction in labor had been run by the operator alone even before the tractor was purchased, and it is possible that on some of them not enough work stock to carry on the work properly had been kept. This was not true in most of the 73 cases, however.

Although the use of a tractor may increase the yield by making possible better tillage practice and more timely work (see p. 46), and may reduce the amount of time which its owner must actually spend at farm work, it is obvious that one will not often prove profitable unless the owner does at least one of the following: (1) Increases the size of his farm; (2) reduces the number of his work stock; or (3) reduces the amount of paid labor used.

OWNERS' OPINIONS REGARDING USE OF TRACTORS.

There are a number of more or less intangible factors connected with the use of tractors which are not directly measurable in dollars and cents, but which nevertheless must be considered in determining whether or not a tractor is profitable. Accordingly each tractor owner was asked a number of questions designed to reveal his opinion and ideas concerning the use of a tractor on his farm. The replies to these questions are summarized in Table 56.

TABLE 56.—*Owners' opinions regarding use of tractors.*

	Southern area.	Western area.	Northern area.	All farms.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Proportion who consider greatest advantage of tractor to be—				
(1) More work in a given time	65	82	57	68
(2) Saving horses in hot weather	28	10	27	22
(3) All other	7	8	16	10
Proportion who consider greatest disadvantage to be—				
(1) First cost and depreciation	34	27	34	31
(2) Running expense	25	31	31	29
(3) All other	41	42	35	40
Proportion who use tractors as primary source of power	64	74	42	59
Proportion who use tractors as supplemetary to horses	36	26	58	41
Proportion who believe tractors responsible for increased yield per acre	29	14	20	21
Proportion who believe tractors have no influence on yield per acre	69	82	79	77
Proportion who believe tractors responsible for decreased yield per acre	2	4	1	2
Proportion who had owned other tractors	25	25	24	25
Proportion who believe present tractors will be profitable	78	84	65	75
Proportion who intend to buy others	75	85	59	72

There are, of course, in the minds of these farmers many advantages and disadvantages connected with the use of tractors other than those listed in the table, but less than 10 per cent of the tractor owners interviewed considered any other single factor the greatest advantage or the greatest disadvantage.

Each farmer was asked whether he planned to use his tractor as the primary source of power for field work, i. e., for all work for which it was satisfactory and to use his work stock only on operations where the tractors could not be used satisfactorily, or whether he planned to use his work stock as the chief source of power and the tractor only during rush seasons or at times when the horses could not work satisfactorily.

As stated on page 46 the majority of these men made some change in their tillage practice after the purchase of their machines, and a great many of them considered that one of the greatest advantages of the tractor was that it enabled them to do their work at the time when it should be done. The value of more thorough tillage than has ordinarily been done and the gains resulting from early preparation of the seed bed for wheat in these areas are unusually recognized. However, other factors, especially the weather, have such a preponderant influence upon yields that it is impossible except over a long period of years to determine definitely the effect of different tillage practices and of performing operations at different dates. Nevertheless each tractor owner was asked whether he considered that the use of his tractor had resulted in any change in yields per acre on any crop in any year.

Finally, each tractor owner was asked if he had owned and used a tractor previous to the one he then had, if he believed his present tractor would prove profitable, and if he intended to buy another when it was worn out.

FARMS ON WHICH TRACTORS WERE NOT OWNED.

The size of the farms on which tractors were not owned and the area in crops are shown in Table 57. The average size of these farms and the average crop area are slightly less than of the farms on which tractors were owned. Likewise the proportion of the crop area in wheat was somewhat less and the proportion in crops planted in the spring correspondingly greater. For these farms 69 per cent of the crop area was in wheat, compared with 74 per cent for the farms on which tractors were owned. The smaller wheat acreage lessens somewhat the requirements of both power and labor during the peak load period of the wheat harvesting and seeding seasons.

In interpreting the data presented concerning these 85 farms it must be remembered that they are not at all typical of all the farms in these areas on which tractors are not owned.

TABLE 57.—*Average size of farms without tractors and acres in crops in different areas.*

Area.	Number of farms.	Acres in—									Total crop area.	Area not cropped.	Total size of farm.
		Wheat.	Barley.	Oats.	Corn.	Other row crops.	Alfalfa.	Other hay.	Sowed feed.[1]	Other crops.			
											Acres.	*Acres.*	*Acres.*
Southern	26	196	.....	13	15	6	8	5	6	1	250	66	316
Western	31	323	29	10	47	10	.....	11	8	8	446	333	779
Northern	28	164	3	10	86	.....	7	4	14	.....	288	88	376
Total	85	232	11	11	50	3	5	7	10	3	334	170	504

[1] Cane, Sudan grass, etc.

NUMBER OF WORK STOCK.

Table 58 shows the number of work stock, their weight, and value on these farms. The average weight of the work stock was not widely different from that on the farms on which tractors were owned. The value placed on them by the owners was on the average

$8 per head greater in the southern area and $21 per head less in the western area, than on the farms where tractors were being used. The proportions of mares, geldings, and mules were practically the same on the two classes of farms.

TABLE 58.—*Total number of work stock, their weight, and value in different areas on farms without tractors.*

Area.	Number of farms.	Mares.			Geldings.			Mules.			Average number work stock per farm.	Average value per head.
		Number.	Average weight.	Average value.	Number.	Average weight.	Average value.	Number.	Average weight.	Average value.		
			Pounds.			*Pounds.*			*Pounds.*			
Southern	26	124	1,283	$110	69	1,277	$86	63	1,137	$130	9.8	$108
Western	31	210	1,219	71	124	1,215	67	44	979	82	12.2	71
Northern	28	136	1,334	113	111	1,305	104	14	1,233	148	9.3	111
Total	85	470	1,277	94	304	1,263	85	121	1,097	115	10.5	94

Table 59 shows the number of colts on these farms. For the entire 85 farms there was one colt less than a year of age for each 7.9 head of work stock and one for each 4.1 mares—a somewhat greater proportion in each case than on the farms where tractors were owned. There were some horses or mules which had not been broken to harness on four-fifths of these farms and on only a little over half of the tractor farms.

TABLE 59.—*Number of work stock and number of colts in different areas on farms without tractors.*

Area.	Number of farms.	Number work stock.	Colts less than 1 year of age.		Other colts.		Number of farms.		
			Horse.	Mule.	Horse.	Mule.	With colts less than 1 year of age.	Other colts.	With no colts.
Southern	26	256	9	19	33	46	14	18	6
Western	31	378	41	26	76	18	21	21	2
Northern	28	261	17	2	27	5	7	13	10
Total	85	895	67	47	136	69	42	52	18

HORSE LABOR.

Table 60 shows the hours of horse labor used per farm on each operation, and Table 61 the hours per head per year, the hours per crop acre, and the crop area per horse on these farms where tractors were not owned. The hours of horse labor per farm was somewhat less than the total power used per farm for drawbar work where tractors were owned (see Tables 22 and 25) but the crop area was correspondingly less, so that the power used per crop acre was practically the same on both classes of farms in each area. On these farms more horse labor was used for plowing and listing than for any other class of work. (See fig. 16.)

Each farmer was asked how many work stock he considered necessary for the proper operation of his farm, and it was found that there were only 25 surplus horses on the entire 85 farms. These men were keeping an average of 10.5 head—one for each 32 crop acres—and they considered that they needed 10.2 head, one for each 33 crop acres. The crop area per horse is the same on the nontractor farms in the southern and northern areas as it was on the tractor farms before the machines were purchased, and about 10 per cent greater in the western area.

TABLE 60.—*Hours of horse labor per farm on which tractors were not owned.*

Operation.	Average number of hours per farm.			
	Southern area.	Western area.	Northern area.	All farms.
Spring plowing	126	234	110	160
Fall plowing	454	1,084	850	814
Listing	615	7	0	191
Total plowing and listing	1,195	1,325	960	1,165
Disking plowed ground	270	0	32	93
Disking unplowed ground	86	775	207	377
Harrowing	741	68	203	318
Sledding	586	6	0	182
Other fitting ground	0	1	4	2
Total fitting ground other than plowing and listing	1,683	850	446	972
Drilling	511	804	404	583
Drawing grain binder	492	58	258	257
Stacking grain	0	44	60	36
Drawing header	48	656	136	299
Drawing header wagons	12	380	90	172
Total harvesting grain crops	552	1,138	544	764
Thrashing	791	258	201	402
Planting row crops	103	321	370	270
Cultivating row crops	226	306	595	377
Drawing row binder	16	74	104	66
Hauling ensilage corn	6	0	9	5
Husking corn	96	271	330	237
Total harvesting row crops	118	345	443	308
Mowing hay	74	41	58	56
Raking hay	43	19	34	32
Loading and hauling hay	73	46	24	47
Sweeping and stacking hay	28	20	64	37
Total haying operations	218	126	180	172
Hauling feed	262	493	257	345
Hauling manure	343	86	283	229
Miscellaneous work on farm	374	217	167	248
Total miscellaneous work	979	796	707	822
Hauling grain on road	449	320	262	340
Other road hauling	73	95	122	97
Total road hauling	522	415	384	437
Total horse labor per farm	6,898	6,684	5,294	6,272
Horse labor hired for threshing	461	12	0	146
Other horse labor hired	19	48	9	28
Horse labor hired out	401	34	[1] 18	141
Total labor by horses owned	6,819	6,658	5,243	6,241

[1] In addition to the horse labor hired out for farm work one farmer used 8,960 hours horse labor during the year for contract work in connection with road building.

In the southern and western areas the hours of work per horse were greater on these farms than on the tractor farms, but as stated on page 26, this was largely due to the large number of surplus work stock kept on the tractor farms.

TABLE 61.—*Horse labor per head, and crop area per horse on farms without tractors.*

Area.	Number of farms.	Horse labor per head per year.	Horse labor per crop acre.	Crop acres per horse kept.	Crop acres per necessary horse.
		Hours.	*Hours.*		
Southern	26	709	27	26	26
Western	31	565	15	37	38
Northern	28	610	19	31	33
Total	85	624	19	32	33

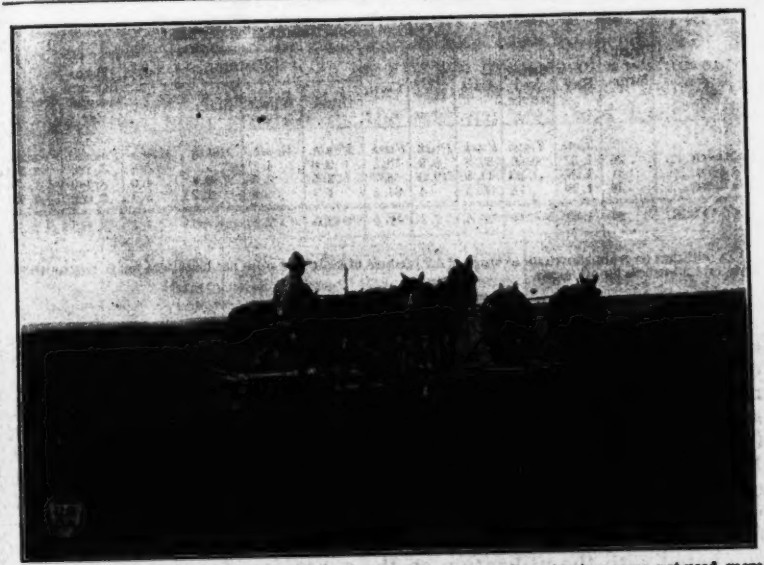

FIG. 16.—Two-bottom lister drawn by six horses. On the farms where tractors were not used, more horse labor was used for plowing and listing than for any other class of work.

COST OF KEEPING WORK STOCK.

Table 62 shows the annual cost per head of keeping the work stock. The costs were computed in the same manner as the corresponding costs on the tractor farms.

TABLE 62.—*Annual cost per head of keeping work stock on farms without tractors.*

Area.	Number of farms.	Cost per head.							Manure credit.	Colt credit.	Net cost per head.
		Feed.	Chores.	Harness.	Shoeing.	Veterinary.	Interest.	Depreciation.			
Southern	26	$39.34	$7.41	$4.35	$0.01	$0.80	$5.88	$7.61	$3.00	$1.85	$83.53
Western	31	34.44	7.02	4.30	0.00	0.17	5.85	7.05	1.50	3.56	53.75
Northern	28	42.87	9.95	3.62	0.19	0.33	9.09	5.55	5.00	1.30	65.30
Total	85	44.02	7.97	4.12	0.06	0.40	7.64	6.79	2.94	2.43	65.63

The annual feed consumption per head is shown in Table 63. In the southern and western areas the horses on the non-tractor farms did considerably more work per head than on the tractor farms and received a correspondingly greater amount of feed. In the southern area the value of the feed consumed per head on the nontractor farms was about $10 greater than on the tractor farms, and in the western area about $5 greater. The time spent per head doing chores was also greater on the nontractor farms in these areas. The average depreciation charge per head amounted to about 7 per cent of the value of the work stock for all nontractor farms, and to between 8 and 9 per cent for all tractor farms. On account of the greater number of colts, the colt credit per head was somewhat greater on the nontractor farms.

TABLE 63.—*Feed for work stock on farms without tractors.*

Area.	Number of farms.	Average annual consumption per head.										
		Hay.	Straw and stover.	Oats.	Barley.	Corn.	Pasture.				Total hay and roughage.	Total grain.
							Grass.	Wheat.	Stalk.	Night.		
		Tons.	*Tons.*	*Bush.*	*Bush.*	*Bush.*	*Month.*	*Month.*	*Month.*	*Month.*	*Pounds.*	*Pounds.*
Southern	26	1.52	0.06	39.6	0.2	10.1	2.0	4.1	.....	3.8	3,160	[1] 2,073
Western	31	1.37	.20	11.9	19.0	8.7	2.6	3.6	0.2	4.0	3,140	1,780
Northern	28	1.39	.14	30.5	.4	34.5	1.3	.9	1.7	3.3	3,060	2,927
Total	85	1.43	.14	26.5	7.1	17.6	2.0	2.9	.6	3.7	3,140	[1] 2,242

[1] In addition to grain shown an average of 3.9 bushels of kafir and milo per head was fed in the southern area, or 1.2 bushels for all farms.

COST OF HORSE LABOR.

For the entire 85 farms the cost per hour of horse labor was 11 cents, compared with 17 cents on the 354 farms on which tractors were owned. In the southern area the cost per hour was 13 cents on the nontractor farms and 22 cents on the tractor farms; in the western area, 10 cents on the nontractor farms and 18 cents on the tractor farms; in the northern area, 12 cents on the nontractor farms and 13 cents on the tractor farms. As stated on page 32 the annual cost of keeping a horse does not increase in proportion to the amount of work it does, and the high cost per hour of horse labor on the tractor farms was very largely due to the low utilization of the work stock compared with the utilization on the nontractor farms.

ANNUAL COST OF POWER FOR DRAWBAR WORK.

Since the work stock on the nontractor farms did all the drawbar work, the cost of keeping them represents the entire cost of power for drawbar work and is comparable to the combined cost of keeping the work stock and of using the tractors for drawbar work on the tractor farms. The average cost on the 85 nontractor farms was $701, or $2.10 per crop acre, compared with $1,025, or $2.91 per crop acre, on the 354 tractor farms. Disposal of the surplus work stock would have reduced the cost somewhat on the tractor farms, and the average cost of power for drawbar work on the tractor farms in 1922 and 1923, if no surplus work stock were kept and if tractors purchased at current prices were used, would have been only a few dollars per year higher than the average cost on the nontractor farms.

The average cost per farm of keeping work stock on the nontractor farms was $838, or $3.35 per crop acre, in the southern area; $670, or

$1.50 per crop acre, in the western area; and $608, or $2.11 per crop acre, in the northern area. As was the case on the tractor farms, there were wide variations in the costs on similar farms of the same size, and the cost could doubtless have been reduced considerably on many of the farms by more efficient management.

CHANGES BETWEEN 1918 AND 1921.

Farmers who did not own tractors were asked for a record of any changes in the size of their farms, in the amount of labor used, and in tillage practice since 1918; that is, during the three years prior to the investigation. Four of the 85 men had started farming during that time and their reports are not included in the following discussion.

SIZE OF FARM.

Table 64 shows the changes in the size of the farms. Forty-four, a little more than half, of the 81 farms had not been changed in size; 31 had been increased in size, and 6 had been reduced. For the entire number there had been an average increase of 45 crop acres. As was the case with the farms on which tractors were owned, the increase had been greatest in the western area and least in the southern area.

TABLE 64.—*Change in size of farm, 1918 to 1921.*

Area.	Number of farms.	No change.		Increased in size.			Decreased in size.			All farms.	
		Number of farms.	Average size.	Number of farms.	Average size.		Number of farms.	Average size.		Average size.	
					1918	1921		1918	1921	1918	1921
			Crop acres.		*Crop acres.*	*Crop acres.*		*Crop acres.*	*Crop acres.*	*Crop acres.*	*Crop acres.*
Southern	24	17	258	5	145	237	2	331	206	240	249
Western	30	13	404	14	333	512	3	443	389	375	453
Northern	27	14	278	12	203	305	1	300	206	246	288
Total	[1] 81	44	308	31	252	388	6	382	297	292	337

[1] Four farms not included, as they had begun operation during the period covered.

LABOR.

Table 65 shows the change between 1918 and 1921 in the amount of family and regular hired labor used on the 44 farms which had not been changed in size. On the average there had been an increase of 0.3 month of regular labor other than that of the operator himself. The size of these farms was less than the size of the tractor farms shown in Table 51, and this fact must be borne in mind in comparing the amount of labor used on the tractor and nontractor farms.

TABLE 65.—*Change in family and regular labor on farms not changed in size, 1918 to 1921.*

Area.	Number of farms.	Average size.	Family and hired labor per farm.		Change.
			1918	1921	
		Crop acres.	*Months.*	*Months.*	
Southern	17	258	5.7	5.1	0.6 decrease.
Western	13	404	5.0	6.4	1.4 increase.
Northern	14	278	6.2	6.4	0.2 increase.
Total	44	308	5.6	5.9	0.3 increase.

CHANGE IN TILLAGE PRACTICE.

These farmers were asked the same questions concerning their tillage practices as were the tractor owners. It was found, however, that only 4 of the entire 85 were making it a practice to plow a greater percentage of their land, plow deeper, or do better seed-bed preparation other than plowing in 1921 than in 1918.

OPINIONS CONCERNING TRACTORS.

To determine the attitude of men who do not own tractors toward their use, each man was asked why he did not own a tractor, and if he intended to buy one in the future. Of the 85 men, 23 stated definitely that they expected to buy tractors in the future, 11 were undecided, and 51 said that they intended to continue farming with horses only. Ten of the 85 men had previously owned tractors but had disposed of them, chiefly because they were considered more expensive than horses.

As a reason for not owning a tractor, the first cost or cost of operating the machine was given by 42 of the 85 men. Some of these 42 stated that the lack of capital alone had prevented their purchasing machines. Sixteen of the men thought the tractors would not be paying investments and 8 considered themselves mechanically incompetent to operate tractors.

COST OF POWER AND MAN LABOR FOR DIFFERENT OPERATIONS.

The average costs per acre of power, and of power and man labor, for the different field operations when done with tractors and horses are shown in Table 66 both for the farms where tractors were owned and those where tractors were not owned. Costs for operations performed by less than 20 men are omitted.

TABLE 66.—*Cost per acre of power and man labor for different operations when done with tractors and horses.*

(Averages for all farms.)

Operation.	Farms on which tractors were owned.						Farms on which tractors were not owned, with horses 1921.		
	With tractors 1921.			With horses 1921.					
	Number performing.	Cost per acre of power.	Cost per acre of power and man labor.	Number performing.	Cost per acre of power.	Cost per acre of power and man labor.	Number performing.	Cost per acre of power.	Cost per acre of power and man labor.
Spring plowing	111	$1.84	$1.84	116	$1.50	$1.99	54	$1.12	$1.61
Fall plowing	200	1.84	2.04	102	1.29	1.75	62	.93	1.34
Listing	43	.96	1.10	43	.82	1.03	25	.54	.74
Sledding	34	1.05	1.17	32	.86	.88	25	.48	.70
Disking plowed ground:									
Single disk	(1)			30	.52	.67	(1)		
Tandem disk	61	.86	.95	(1)			(1)		
Disking unplowed ground:									
Single disk	(1)			37	.40	.55	40	.30	.44
Tandem disk	102	.79	.89	30	.89	1.09	(1)		
Disking in combination	46	.92	1.03	0			0		
Harrowing	101	.39	.45	181	.24	.32	63	.20	.28
Drilling	104	.60	.68	273	.39	.52	85	.28	.40
Listing corn	41	.86	1.09	224	.78	1.04	66	.54	.78
Drawing binder	177	.68	.87	188	.43	.56	67	.34	.43
Drawing header	22	.40	.51	106	.33	.41	47	.34	.31
Drawing combine	34	.72	.85	0			0		

1 Performed by less than 20 men.

Costs for power are based upon the costs of using tractors and of keeping work stock on the individual farms during the year covered by the investigation. The cost of man labor has been calculated at the flat rate of 20 cents per hour for man labor on all farms both when using tractors and when using horses. Costs for the grain binder, header and combine when drawn with tractors include the labor of a man on the machine as well as that of the tractor operator. The labor of only one man is included in the costs of all other operations shown.

Costs per acre in 1922 of power with tractors were computed on a basis of 75 per cent of the costs for the year of the investigation, and the same rate (20 cents per hour) was charged for man labor.

On account of the lower cost per hour of horse labor on the farms where tractors were not owned the costs per acre of power for the different operations were in every case lower than the costs for the same operations when done with horses on the farms where tractors were owned.

FARMS ON WHICH NO HORSES WERE OWNED.

Eleven farms in the western area kept no work stock. On two of these farms no horse labor was used for planting and harvesting the one crop, wheat. A combine drawn by the tractor was used in each case to harvest the crop. On the remaining nine farms horse labor was hired as needed, usually to harvest wheat, an average of 1,025 hours for the nine farms being used.

These farms were much smaller than either of the other classes previously discussed—454 acres in total size, and 306 acres in crops, of which 271 acres, about 90 per cent, was in wheat. (See Tables 2 and 3.) On seven farms wheat was the only crop grown. The tractors were used for 82 per cent of the total drawbar work on these seven farms, compared with 76 per cent on the entire 11.

The drawbar work on the 11 farms amounted to an equivalent of 10 hours of horse labor per crop acre, compared with 15 hours on the farms where some horses were owned. (See pages 25 and 53.)

TABLE 67.—*Utilization and cost of using tractors on farms on which no horses were owned.*

Item.	Average per tractor.	Item.	Average per tractor.
Number of farms	11	Fuel per year for drawbar work:	
Age of tractor...months..	12.8	Gasoline...gallons..	349
First cost of tractor...dollars..	1054	Kerosene...do....	219
Estimated total life...years..	5.8	Oil per year for drawbar work...do....	49
Annual cost of repairs and upkeep ...dollars..	25.00	Cost of using tractor for drawbar work:	
Tractor work per year:		Per year...dollars..	300.00
Drawbar (home farm)...hours..	293.2	Per hour...do....	1.36
Belt (home farm)...do....	.5		
Custom (home farm)...do....	90.0		
Total (home farm)...do....	383.0		

Sixty-four per cent of the tractors were of the two-plow size. The first cost, annual cost of repairs and upkeep, and cost per year and per hour for drawbar work are less on these farms than on the 1-tractor-and-horse farms on which only 31 per cent of the tractors were of the two-plow size. More custom work but considerable less

belt and drawbar work was done than on the farms having one tractor in addition to horses. The estimated total life was one-half year less than that of the tractors on the other farms.

Seven of the eleven farmers began farming without horses. The entire number considered their tractors profitable investments and five found no disadvantage in using them.

FARMS ON WHICH TWO TRACTORS WERE OWNED.

Two tractors were owned and used for drawbar work on 6 farms in the southern area, 13 in the western area, and 2 in the northern area. A summary of the utilization and cost of using the tractors on these farms in the western area (being the largest group) is given in Table 68.

TABLE 68.—*Utilization and cost of using tractors, farms on which two tractors were owned (western area).*

Item.	Average per tractor.	Item.	Average per tractor.
Age of tractor.....months..	[1] 26.4	Fuel per year for drawbar work:	
First cost of tractor.....dollars..	[1] 1,606.00	Gasoline.....gallons..	538
Estimated total life.....years..	[1] 6.3	Kerosene.....do....	376
Annual cost of repairs and upkeep .....dollars..	90.00	Oil per year for drawbar work....do....	57
Tractor work per year:		Cost of using tractor for drawbar work:	
Drawbar (home farm).....hour..	315	Per year.....dollars..	595.00
Belt.....do....	19	Per hour.....do....	1.89
Custom.....do....	24		
Total.....do....	359		

[1] Five tractors purchased secondhand not included.

The two-tractor farms are more than 300 acres larger than the one-tractor farms in the same area. The percentage of the total area in crops likewise is greater (75 per cent and 61 per cent, respectively) as is the percentage of crop area in wheat (87 per cent and 79 per cent, respectively). But 3 of the 13 farms have a crop area smaller than the average crop area for the one-tractor farms.

Of the 26 tractors, of which Table 68 is a summary, 5 were purchased second-hand at an average cost of $760 compared with $1,606 for the new tractors. All told, there were seven 2-plow tractors, nine 3-plow, five 4-plow, and five larger. On one farm only were two tractors of 2-plow size used. On six of the farms, however, the two tractors were of the same size. On seven of the farms at least one 4-plow tractor was owned.

There is no marked difference between the utilization and cost of using tractors on the two-tractor farms and on the farms on which one tractor is owned. In the former group the first cost is somewhat larger because larger sized tractors are used; repairs are slightly more, and estimated total life one-half year less; there is a difference of but 17 hours in the total utilization per year. There is a difference of $111 per year in the cost of using tractors for drawbar work (40 cents per hour) in favor of the one-tractor farms.

It would have required 7,154 hours of horse labor to accomplish the drawbar work done with the tractors on these farms. This represents 78 per cent of the total drawbar work compared with 46

per cent for the one-tractor farms. On the two-tractor farms nearly half of the ground seeded to small grain had no preparation previous to drilling, while only about one-fifth of the ground on the one-tractor farms had no previous preparation. Consequently, the equivalent of but 10 hours of horse labor was required for the drawbar work on each crop acre on the former farms as compared with 14 hours on the one tractor farms.

TABLE 69.—*Utilization and cost of keeping work stock.*

Item.	Average per farm.	Item.	Average per farm.
Number of farms	13	Annual feed consumption:	
Work stock per farm	10.1	Grain, pounds	481
Value per head, dollars	83.00	Hay, do	1,978
Annual cost per farm of keeping work stock, do	504.00	Pasture, months	9.3
Annual cost per head of keeping work stock, do	48.00	Horse labor per farm, hours	2,025
		Horse labor per head, do	234
		Cost per hour, dollars	0.25

The utilization and cost of keeping the work stock on the 13 farms is summarized in Table 69. There was one head for every 88 crop acres on these farms compared with one head to 51 crop acres for the one-tractor farms in the same area. It cost $2 per head less per year to keep these horses and they worked on an average 234 hours per year compared with 393 hours for the one-tractor farms. The grain fed per head was 60 per cent less, and the number of months on pasture was 20 per cent greater.

Before the tractors were brought to these farms they were less than half their present size and required practically the same number of work stock, one for every 39 crop acres.

All of the drawbar work on the two-tractor farms (895 crop acres) would have required 24 horses without the aid of the tractors, and since there is a present supply of 10 head, the two tractors have apparently displaced an average of 14 head of work stock per farm.